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STARVED ROCK DAM AND POOL, ILLINOIS RIVER WATERWAY—IMPROVEMENT COMPLETED DURING 1933 (SEE PAGE 489)

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SEPTEMBER 1933

TENNESSEE VALLEY

Government Begins Development in Seven States of an Area of 42,000 Square Miles Under Direction of the Tennessee Valley Authority

CHATTANOOGA, TENN., AND LOOKOUT MOUNTAIN

MCUNTAINEER'S CABIN IN THE GREAT SMOKY MOUNTAINS

LOCK CONSTRUCTION AT GENERAL JOE WHEELER DAM (DAM NO. 3)

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ARTIST'S CONCEPTION OF THE PROPOSED NORRIS (COVE CREEK) DAM ON THE CLINCH RIVER

Photographs from Ewing Galloway, New York, N.Y.

ALTHOUGH cheap power and fertilizer are to be made available, the stated aim of the Tennessee Valley Authority is to develop the valley according to a far-reaching program of social and economic planning. It contemplates the coordination and control of all the water resources of the region to bring about the greatest total benefit in water power, water supply, flood control, and navigation. It will concern itself with the checking of soil erosion by reforestation and better farming methods. It will undertake to develop industries adapted to the region; to consolidate county governments; to increase the economic wealth of the area; and to raise the standard of living of the poor hillside farmer.

One of the large engineering projects in connection with the development of the Tennessee River drainage area, is the construction of the 245-ft Norris (Cove Creek) Dam on the Clinch River, near Knoxville. Located about 400 miles by river above the existing Wilson Dam at Muscle Shoals, it will, when completed, store over three million acre-feet of water, enough to generate 165,000 kw of power at Norris Dam and to more than double the available power output at Wilson Dam. A unique feature of the dam is a barge lift, the entrance of which appears to the left of the power house in one of the illustrations. It is estimated that the dam will cost about 34 million dollars. On the Tennessee River, 15 miles above Wilson Dam, work has already started for the navigation lock at the General Joe Wheeler Dam.

In the words of Arthur E. Morgan, M. Am. Soc. C.E., Chairman of the Tennessee Valley Authority, "Not by dictation, but by cooperation and demonstration, the fundamentals of a planned social and economic order may be introduced into this region."

Among Our Writers

LANGDON PEARSE has spent 32 years in sanitary engineering. Since 1909, as Sanitary Engineer of Chicago, he has been occupied with the sanitary developments of the city, including investigations on domestic sewage, industrial wastes, and the design of treatment plants.

D. B. STEINMAN has participated in the design of the Hell Gate Arch Bridge over the East River and the George Washington Bridge over the Hudson River in New York City; the Florianopolis Bridge in Brazil; and the Sciotoville Bridge over the Ohio River.

A. A. JAKKULA has done considerable research in the thermal properties of cement and concrete, as well as in welding and problems of structural analysis. Formerly he was Research Fellow at the University of Minnesota.

ALMON L. FALES, a partner in the firm of Metcalf and Eddy, of Boston, Mass., is considered an authority on matters pertaining to water purification, sewage treatment, the disposal of industrial wastes, and the elimination of odors.

L. F. WARRICK, after graduation from the University of West Virginia, specialized in public health problems. He is the author of many technical works. Since 1925 he has been employed by the State of Wisconsin.

W. D. HATFIELD is a specialist in the bacteriology and chemistry of sewage treatment. In 1931 he was a joint recipient of the Thomas Fitch Rowland Prize. Formerly he was Professor of Physical and Organic Chemistry at Montana State College.

A. P. M. FLEMING, a graduate of English colleges, is author of *Engineering as a Profession* and *Insulation and Design of Electrical Windings*, published in London in 1913. He is also part-author of various technical papers read before the Institution of Electrical Engineers in London.

HUGH E. YOUNG is Chief Engineer of the Chicago Plan Commission, and also consultant to the South Park Commissioners in the design and construction of the Outer Drive improvement.

JOHN H. MILLAR was recently in charge of the National Conference on Slum Clearance called by the City of Cleveland. Prior to becoming editor of *The Housing Letter*, he was Chicago editor of *The Business Week* and, earlier still, was president of the Home News Publishing Company.

WILLIAM G. GROVE, who holds degrees from the University of Pennsylvania, was for 28 years with the American Bridge Company. In 1916 he was awarded the Society's James Laurie Prize, and in 1929 the Thomas Fitch Rowland Prize.

D. H. SAWYER was Constructing Quartermaster in the U.S. Army (1917–1919) in charge of building cantonments. For 6 years he was secretary of the Associated General Contractors of America.

ARTHUR E. GORMAN is Engineer in Charge for the City of Chicago of all water-purification activities, including chlorination and filtration, and research and design studies.

JOHN R. BAYLIS designed the experimental filter plant at Chicago, and assisted in the design of the new plants under construction. He was awarded the Society's James Laurie Prize in 1927.

JACOB L. CRANE, JR., is now acting as regional planner for the Tennessee Valley Authority. His planning activities include 70 projects located in this country and in Latin America, China, and Russia.

JOHN WILSON, as City Engineer of Mankato, Minn., investigated the typhoid epidemic of 1908 and remodeled the city's water and sewer plants. He has been City Engineer of Duluth, Minn., for the past 13 years.

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VOLUME 3 NUMBER 9

Sewage Disposal by Way of the Illinois River

Past, Present, and Future Aspects of the Problem

By LANGDON PEARSE
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
SANITARY ENGINEER, THE SANITARY DISTRICT OF CHICAGO

OPENING of the 9-ft Illinois Waterway above Grafton was celebrated in June of this year. Its commercial aspects, as they affect metropolitan Chicago, were presented in the August issue of CIVIL ENGINEERING. *Of no less importance are its sanitary aspects. It is necessary to keep this waterway clean to protect those who work on or near it and to maintain fish life in it. In a paper read before the Sanitary Engineering Division of the Society on July 30, 1933, during the Annual Convention in Chicago, Mr. Pearse showed the extent to which industrial and domestic sewage has damaged the usefulness of the Illinois River. He described the steps that are being taken to treat Chicago's sewage before its discharge into the Drainage Canal and mentioned practical standards that have been suggested in order to keep the water free from objectionable qualities. This article is an abstract of the paper read at the Convention.*

FIG. 1. MAP OF ILLINOIS RIVER AND TRIBUTARIES

IN its natural state the Illinois River served to drain a watershed of approximately 28,167 sq miles, to which were added in 1933 the Sanitary District of Chicago and other areas aggregating 804 sq miles, making a total of 28,971 sq miles. A hundred years ago 29,000 people resided on the watershed and the entire population of the State of Illinois was but 157,445. In 1930, the population on the original watershed had grown to 1,856,000, and in the Sanitary District there were 3,901,569 more, making a grand total of 5,757,569. The population of Illinois had increased to 7,630,654.

In the past one hundred years there have been three distinct stages in the development of the Illinois River. The first was its natural state, which existed prior to the opening of the Illinois and Michigan Canal in 1848. In this period a minimum dry flow at Peoria of 525 cu ft per sec was reported. In the second stage improvements were begun. The lower river was canalized by dams at Kampsville, La Grange, and Copperas Creek, and the upper river by one at Henry. From LaSalle to Bridgeport, the Illinois and Michigan Canal was used. In 1907, the Main Channel of the Sanitary District was connected to the river, and the Illinois and Michigan Canal from Lockport to Chicago fell into disuse as a waterway. A map of the Illinois River is shown in Fig. 1.

At that time the upper river was still relatively swift, although a dam had been built at Marseilles in 1865 and another at Joliet in 1900. From the Power House to Starved Rock, a drop of about 94 ft in 59 miles was all slope or rapids, except for the 16½-ft dam at Marseilles and the 9-ft dam at Joliet. Through Joliet, the drop was 20 ft in 2¾ miles, and from Brandon Road to Dresden Island it was 21.5 ft in 14 miles. The present 9-ft waterway from Lockport to Grafton, opened in 1933, constitutes the third stage in the development of the river. In the upper river a succession of pools has replaced the swift water. Of the 98-ft drop from above Brandon Road to below Starved Rock, 92 ft is utilized by dams and only 6 ft is available for slope in 60 miles when 6,000 cu ft per sec is diverted from Lake Michigan.

Comparatively little information is available concerning the sanitary condition of the Illinois River prior to 1899. Apparently the condition of the river began to deteriorate as early as 1870 owing to the growth of population and industry, particularly in the Peoria and Chicago areas. Self-purification in the upper section prior to 1900 is indicated and also an improvement following the opening of the Main Channel of the Chicago Drainage Canal in 1900.

About 1909, the spread of pollution downstream was evidenced by changes in the fauna. By the summer of 1920 the bottom fauna had so deteriorated that the normal bottom population had almost entirely disappeared from Chillicothe to Beardstown. By 1925, adult commercial mussels had disappeared practically as far south as Havana.

Conditions changed for the better about 1926, when successive improvements were completed, such as the

cutting down of the corn products waste in 1926, and the putting into service by the Sanitary District of the North Side Sewage Treatment Works in 1928 and the West Side Treatment Works in 1929. However, in 1930 the annual average diversion from Lake Michigan was cut to 6,500 cu ft per sec.

From its inception in 1877, the Natural History Survey of Illinois has taken a keen interest in the fauna of the Illinois River, including the fisheries. In its various bulletins are recorded studies regarding gases, bed sediments, fish, mussels, and plankton, as well as other plant and animal life of the bed and shores.

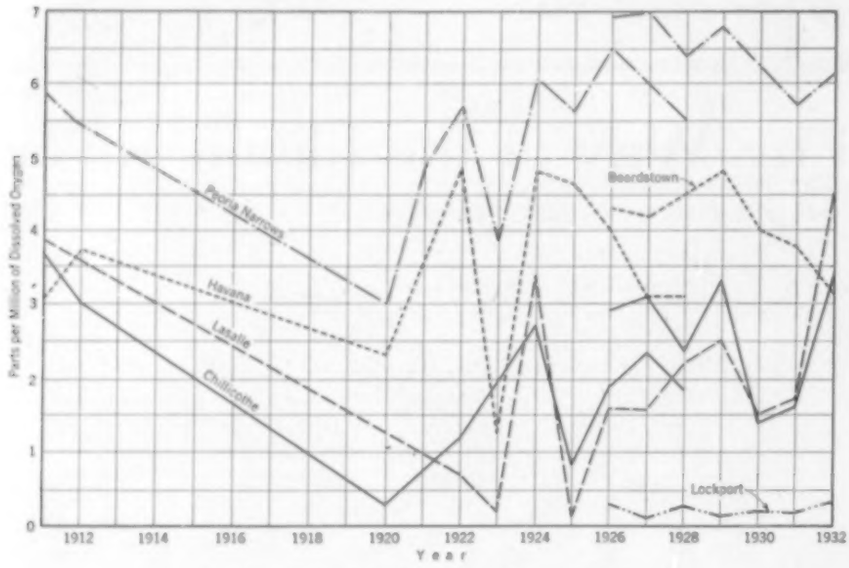

FIG. 2. DISSOLVED OXYGEN IN ILLINOIS RIVER

Catch Samples Taken by Illinois State Water Survey from 1911 to 1928, and Four-Month Averages of Samples Taken by Sanitary District of Chicago from 1926 to 1932

The fish catch in the Illinois River appears to have increased from 1900 up to 1908 or 1909 and thereafter to have declined to a low in 1921, apparently rising since that year. The yield in the upper river decreased first and then that in the middle river. The pertinent factors appear to be the reclamation of bottom lands, the exclusion of fish from large areas of the upper and middle river due to pollution, and occasional periods of extraordinary pollution which have wiped out the food as well as the fish. The principal fish is carp, which was first introduced in the river about 1885. By 1898 the catch exceeded in value that of all other commercial fish; by 1906 it reached 64 per cent; and in recent years it has been about 90 per cent of the catch. At one time the mussel industry was active, a taking of 32,000,000 lb being reported in 1908, but the take declined to 2,760,000 lb in 1912 and to 1,070,000 in 1931.

Observations made in the summer of 1923 indicate that with less than 2 ppm of dissolved oxygen, fish die overnight. Observations made in the winter indicate that all kinds of fish in the Illinois River die when the dissolved oxygen goes below 2 ppm. In Bulletin 15 of the Illinois Natural History Survey, Thompson notes that "carp and buffalo have been found living in water showing as low as 2.5 ppm. As a rule, a variety of fishes were found only when there were 4 or more parts per million, and the greatest variety of fishes was taken when there were 9 ppm."

In Table I are given the sewered populations of the cities draining directly into the Main Channel, the Des Plaines, and the Illinois rivers, together with the estimated amount of industrial waste as of 1930 entering these bodies of water. The population for Chicago is based on the estimate of the Engineering Board of Review, with the waste from the corn products grind corrected. The data for the other cities are taken from Circular No. 12 (1931) of the Illinois State Water Survey.

As shown in Table II, the flow in the Chicago Drainage Canal has varied from year to year. The maximum annual average flow, which occurred in 1928, was 10,010 cu ft per sec, or a net diversion of 8,400 cu ft per sec. The court decree of April 30, 1930, permits an annual average diversion from Lake Michigan in addition to the water works pumpage. Under present methods of operation, to prevent reversals of the direction of flow in the Chicago River, the diversion is increased during rain storms. Depending on the prevailing lake level and the duration, extent, and intensity of the rainfall, of late years the daily flow at Lockport has occasionally risen to 14,000 cu ft per sec. To balance this, the flow is reduced in fair weather below the authorized annual average. The annual average diversion now authorized is 6,500 cu ft per sec. On December 31, 1935, this amount is to be cut to 5,000 cu ft per sec, and on December 31, 1938, a further cut to 1,500 cu ft per sec is indicated. Based on a study of the probable excess flows required above the average to control reversals of the Chicago River, with an annual diversion of 1,500 cu ft per sec, the working diversion for six months of the year may be from 750 to 1,000 cu ft per sec.

TABLE I. EQUIVALENT POPULATION OF ILLINOIS RIVER CITIES

Gross Totals Indicated as of 1930

PLACE	STATION (Miles from Grafton)	SEWERED POPULATION IN 1930	POPULATION EQUIVALENT OF INDUSTRIAL WASTES	TOTAL SEWERED POPULATION CONTRIBUTING
Chicago (Sanitary District)	...	3,901,569	1,732,000	5,633,569
Lemont	...	2,582	.....	2,582
Lockport	292	3,383	.....	3,383
Joliet	288	42,993	26,000	68,993
Rockdale	...	1,701	.....	1,701
Morris	263	5,868	30,000	35,568
Marseilles	247	4,292	102,000	106,292
Ottawa	240	15,094	3,000	18,094
LaSalle	223	13,149	.....	13,149
Peru	222	9,121	1,000	10,121
Spring Valley	218	5,270	.....	5,270
Peoria Heights	166	3,279	50,000	53,279
Peoria	162	104,969	1,000,000	1,104,969
Pekin	153	16,129	200,000	216,129
Havana	120	3,451	.....	3,451
Beardstown	89	6,344	.....	6,344
Total		4,138,894	3,144,000	7,283,394

By careful hydraulic control, under constant supervision, it has been found practicable to operate the canal system and prevent reversals of flow into the lake through the Chicago River with an annual average diversion as low as 6,500 cu ft per sec. Various tests indicate that the annual average diversion may be cut to 5,000 cu ft per sec without increasing the potential danger to the water supply, provided the West Side intercepting sewer system is completed and the sewage intercepted on both sides of the main river.

From 1911 to 1928, the Illinois State Water Survey conducted various tests on the river by taking catch samples. The graphs from the survey, reproduced in Fig. 2, show the downward trend to less than 0.5 ppm of dissolved oxygen from 1911 to 1923 at La Salle, and from 1911 to 1920 at Chillicothe, and the subsequent upward trend. The dissolved oxygen at Peoria Narrows was 3 ppm or higher during the whole period of record. The graph for Havana is typical of the lower river.

GENERAL DECREASE IN BIO-CHEMICAL OXYGEN DEMAND DOWNSTREAM FROM LOCKPORT

From 1926 to date the Sanitary District of Chicago has taken samples for the same purpose. These data, the averages for the four months, June to September, inclusive, also appear in Fig. 2. For the lower river Beardstown is taken as typical.

TABLE II. TOTAL FLOW CHICAGO DRAINAGE CANAL AND ANNUAL AVERAGE DIVERSION FROM LAKE MICHIGAN AT CHICAGO

1900–1932, in Cubic Feet per Second

YEAR	CHICAGO'S CENSUS POPULATION	TOTAL FLOW AT LOCKPORT	INFLOW FROM WILLOW SPRINGS SPILLWAY	DOMESTIC PUMPAGE, CHICAGO METROPOLITAN AREA	NET DIVERSION FROM LAKE MICHIGAN
1900	1,638,656	2,990	..	449	2,541
1901		4,046	..	531	3,515
1902		4,302	..	554	3,748
1903		4,971	..	582	4,389
1904		4,793	..	618	4,175
1905		4,480	..	636	3,844
1906		4,473	..	676	3,797
1907		5,116	..	704	4,412
1908		6,443	..	726	5,717
1909		6,495	..	744	5,751
1910	2,308,276	6,833	..	803	6,036
1911		6,896	..	785	6,111
1912		6,938	..	853	6,085
1913		7,839	..	894	6,945
1914		7,815	..	949	6,866
1915		7,738	..	939	6,799
1916		8,200	..	972	7,228
1917		8,726	..	993	7,733
1918		8,826	..	1,018	7,808
1919		8,595	..	1,106	7,489
1920	2,986,000	8,346	..	1,176	7,170
1921		8,355	..	1,199	7,156
1922		8,858	..	1,216	7,642
1923		8,348	..	1,220	7,128
1924		9,465	..	1,274	8,191
1925		8,278	0	1,338	6,940
1926		8,283	15	1,395	6,873
1927		8,450	5	1,460	6,985
1928		10,010	45	1,565	8,400
1929		9,450	70	1,680	7,700
1930	3,901,569	8,346	0	1,700	6,646
1931		8,180	0	1,685	6,495
1932		8,099	2	1,644	6,453

The populations given are for the actual area of the Sanitary District of Chicago. Flows are taken from the Hughes Report and the semi-annual reports to the U.S. Supreme Court.

That there has been a general decrease in the bio-chemical oxygen demand downstream and an increase in the available dissolved oxygen, is shown in Fig. 3. The general trend of the bio-chemical oxygen demand at Lockport has been downward since 1929.

In the control of the Illinois River the re-aeration factor is important. Attention is being given to determining its quantitative value, particularly for the new conditions. Basically, the amount depends on time, temperature, turbulence, and degree of deoxygenation of the liquid.

Between the Lockport Power House and Peoria a number of tributaries reach the Illinois River, the major ones being the Des Plaines, Kankakee, Fox, and Vermilion rivers. At low water, the daily flows are relatively small. In the investigations of the Public Health Service made above Chillicothe in 1921 and 1922, the flow from the tributaries brought in daily was found to average from 26,420 to 896,300 in pounds per day of dissolved oxygen net, over a period of 13 months.

Generally, when water falls over dams marked aeration occurs, from which some additions to the dissolved oxygen result. To what extent such dissolved oxygen is

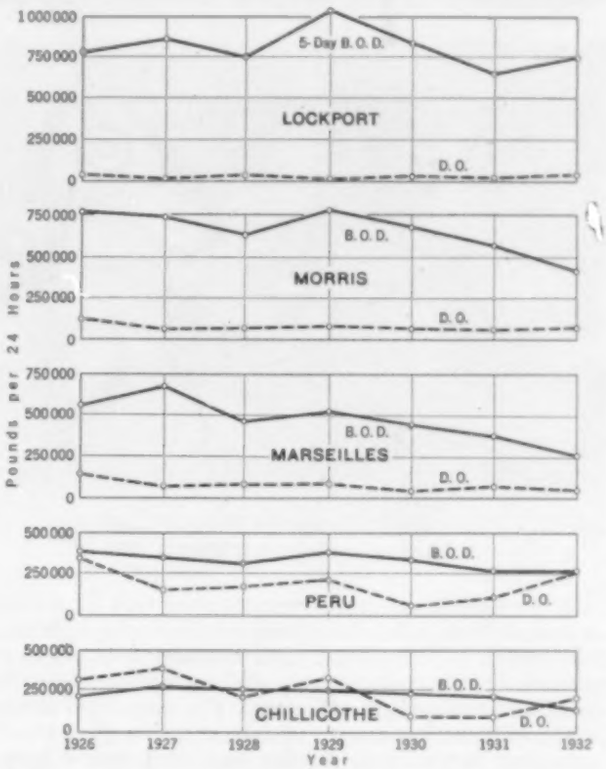

FIG. 3. DISSOLVED OXYGEN AND FIVE-DAY BIO-CHEMICAL OXYGEN DEMAND

At Points on the Illinois River

made available and satisfies the bio-chemical oxygen demand, only special tests will indicate.

At the Marseilles Dam, from 1926 to 1933, when monthly averages were taken for 87 months, the minimum monthly pick-up of dissolved oxygen was 1.0 ppm, the maximum 4.3 ppm, and the average 2.85 ppm. In general, the pick-up was greater in the warmer months, particularly when the oxygen was nearly exhausted above the dam. In the colder months, when the oxygen content was much higher above the dam, less pick-up occurred.

Prior to 1933, the time of flow from Lockport to Chillicothe varied between 5 and 6 days for flows at Chillicothe under 15,000 cu ft per sec and over 8,000. From Lockport to Morris, the time of flow has been about 0.6 day for the same range of flow at Morris. With the new pools, the time of flow from Lockport to Chillicothe is approximately 10 days, when the flow at Chillicothe is 5,000 cu ft per sec, and 7 days when it is 10,000 cu ft per sec. From Lockport to Morris, the time of flow is approximately 4 days at 5,000 cu ft per sec and 1.8 days at 10,000 cu ft per sec. When there is a diversion of 1,500 cu ft per sec, the flow period from Lockport to Chillicothe is approximately $12\frac{1}{2}$ days and that from Lockport to Marseilles, 5.8 days.

The sewage treatment program of the Sanitary District was originally divided into five general parts: the West Side, Southwest Side, North Side, Calumet, and

Des Plaines River projects. In the revised program, the West Side and Southwest Side works are to be placed on the 500-acre site acquired for the West Side Project. The Des Plaines River Project has been consolidated with the West Side Project. The progress in treatment on the basis of sewered population is shown in Table III.

Since July 1930 the North Side Sewage Works has been operated to give complete treatment. By successive steps, it has been demonstrated that an average of over 200 mgd can be handled, allowing a 5-hr aeration period. The amount of air has been reduced to approximately 0.4 cu ft per gal. When the plant has been operated at maximum efficiency, the suspended matter in the effluent has been reduced at times to under 10 ppm, and the average for the year 1932 was 12 ppm. Likewise, the 5-day bio-chemical oxygen demand has been reduced to below 8 on monthly averages, and the average for the year 1932 was 9.7 ppm. The flow has varied from 170 to 220 mgd in the monthly averages, the maximum for a single day being over 300 mgd.

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THE ILLINOIS RIVER AT STARVED ROCK
Construction of Lock and Dam in 1928

Battery A of the West Side Works was put in service on June 2, 1930, and Battery B was added in January 1931. Both batteries now handle the sewage of only a part of the West Side Project area. However, they settle the sewage from all the intercepting sewers that have been built to date. When the sewage from the North Side was turned into this plant, the admixture of the North Side sludge, containing both fresh and activated solids, brought in more solids than the two batteries could digest. The moisture content of the digested sludge seldom went below 94 per cent. Because of this condition the experiment has been tried of operating one battery on West Side sewage alone and the other on a mixture of North and West Side sewage. Further, two separate digestion tanks, heat controlled, have been installed, with capacities of 390,000 and 315,000 gal, respectively, to test the effect of separate digestion. The result indicated practically the same moisture content as in the Imhoff tanks.

TABLE III. PROGRESS IN SEWAGE TREATMENT ON THE BASIS OF SEWERED POPULATION, CHICAGO SANITARY DISTRICT

DATE	POPULATION EQUIVALENT	TREATMENT ON 100 PER CENT BASIS†
1914	936	796
1920	1,080	916
1922	119,620	64,200
1924	142,230	79,500
1925	163,200	91,800
1929 (Dec. 31)	921,000*	727,000
1930 (June 24)	1,603,000*	1,144,000
(Dec. 25)	2,153,000*	1,473,000
1931 (June 25)	2,173,000*	1,455,000
1932 (June 25)	2,428,000*	1,562,000
1933 (June 25)	2,459,000*	1,595,000

* Figures include population equivalent of Corn Products Refining Company (*Argo*)

† 100 per cent basis is calculated by allowing 85 per cent treatment for activated sludge and 33⅓ per cent for sedimentation.

In the operation of the Imhoff tanks, the suspended solids have been reduced between 9.0 and 72.2 per cent on a monthly average, and 57.8 per cent on a yearly average (for 1931). The 5-day bio-chemical oxygen demand was reduced 56.2 per cent on an annual average. The North Side sludge has been digested in varying amounts, ranging from 0 to 63.0 per cent. Because of the discharge of undigested sludge, the full effect of the treatment has not yet been realized. A third battery of Imhoff tanks, with enlarged sludge storage capacity, was put under contract in 1931, but is only half finished because of lack of funds. However, exhaustive tests have been made on sludge dewatering and incineration with a view to eliminating both sludge digestion and air drying in the future extension. An activated sludge plant is planned for this extension.

The Calumet Works has been in operation since August 1922, primarily as a sedimentation plant serving a steadily increasing population. At this works paint wastes have proved troublesome. The period of settling has been steadily decreased. The plant handled about 55 mgd in 1931 and 1932. The suspended matter was reduced between 29 and 61 per cent on monthly averages, and between 47 and 49.5 per cent on yearly averages. The 5-day bio-chemical oxygen demand has been reduced between 20 and 56 per cent on monthly averages, and between 29 and 30 per cent on yearly averages. An activated sludge plant is also planned for this extension. Although contracts for much of it were let in 1931, little has been accomplished because of lack of funds.

The operation of the treatment works in Chicago and reduction of the corn products wastes have aided in improving conditions in the Illinois River. Fish are reported to be appearing in the upper section.

STANDARD OF MAXIMUM POLLUTION IN RIVER

In various reports and in the litigation, standards have been suggested for the discharge of the Main Channel at Lockport and for the Illinois River. They were formulated largely from the practical standpoint that the navigable water should be free from objectionable qualities, both from the viewpoint of those who travel in boats and that of those who live or work along the shore. In the case of Wisconsin et al. vs. Illinois et al., various suggestions for maintaining suitable conditions in the Des Plaines and Illinois rivers were made by different witnesses.

In the introduction of their report to the District Engineer, Louis R. Howson and Charles B. Burdick, Members Am. Soc. C.E., said:

> In the consideration of sewage treatment works that will be required under various drafts of dilution water from Lake Michigan, it has been necessary to fix a standard of maximum pollution for the Chicago Drainage Canal in order that reasonable sanitary conditions may be maintained in the Des Plaines and Illinois rivers. We suggest the following as a reasonable standard:
>
> The liquid discharged by the Drainage Canal, as evidenced by the average of representative samples taken from any 30 consecutive days shall: (*a*) Be practically free from settleable solids de-

posited in two hours, and, (*b*) Shall contain dissolved oxygen equal to or exceeding the bio-chemical oxygen demand of said liquid for 5 days when incubated at 20 C. (*c*) Shall contain not less than three parts per million of dissolved oxygen.

Harrison P. Eddy, M. Am. Soc. C.E., and his subcommittee of the Engineering Board of Review suggested 1 cu ft per sec per 1,000 population as a residual dilution after complete treatment had been extended to the entire equivalent population. This was based on taking care of the residual population, diluting the nitrates, reducing the likelihood of secondary nuisance difficulties with algae, and providing a factor of safety.

As a witness, the late Edgar Jadwin, M. Am. Soc. C.E., stated that in his opinion a minimum total diversion at Lockport of 4,167 cu ft per sec was necessary to prevent a nuisance in the Illinois and Des Plaines rivers and permit fish to live there. To allow for contingencies, he placed the eventual amount at 5,000 cu ft per sec, measured at Lockport.

In his testimony, Mr. Eddy set up what he considered a reasonable standard for the waters of the Port of Chicago, that is, those above Lockport, from the viewpoint of navigation.

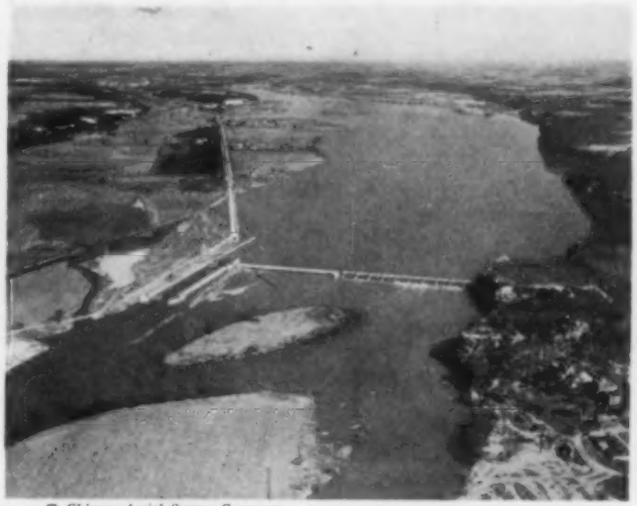
1. The water should be practically free from visible suspended particles of sewage matter coming from sewage treatment plants.
2. The water should be practically free from oil, grease, color, and suspended matter.
3. The water should not be obnoxious or offensive to, or injuriously affect the health of, passengers and persons employed on vessels or other property used in connection with navigation.
4. The water should not create odors of putrefaction of organic matter.
5. The waters should not be of such composition as to result in an excessive growth of water plants.
6. The water should not cause discoloration of paint on, or otherwise injure, vessels and equipment or other property employed in connection with navigation.
7. The water should contain at least three parts per million of dissolved oxygen.

In specifying an annual average diversion of 2,000 cu ft per sec as of 1945, or $\frac{1}{3}$ cu ft per sec per 1,000 population, based on total equivalent population in addition to sewage and overflow run-off, Mr. Eddy did not consider the additional water that might be required to maintain suitable conditions for navigation in the Des Plaines and Illinois rivers. He stated that in warm weather from 3,000 to 4,500 cu ft per sec might be required for this purpose.

Any tentative standard would seem to require the maintenance of at least 3 ppm of dissolved oxygen in the Des Plaines and Illinois rivers, because of the difficulty of keeping an exact control at all times over all the factors entering into the problem. By this means nuisances would be prevented and fish life maintained. Further, the requirement that settleable solids be practically removed is sound, for it would minimize the formation of sludge banks in the pools. To maintain an oxygen balance, a supply of dissolved oxygen should be available to meet the bio-chemical oxygen demand as required. Flushing of pools by opening the sluiceways in the dams may prove helpful, particularly at times of high water.

When the sewage has been intercepted and complete treatment given, the question of storm overflows remains. Practically all the sewers in the Sanitary District are built on the combined system. Only a few districts, limited in area and mostly suburban, have separate systems. As a result the overflow outlets may be in action on an average of about 53 times during the year. During a major storm, a large part of the raw sewage may be discharged directly into the river or channel. It may be desirable to flush the North Shore Channel and the South Fork of the South Branch of the Chicago River by means of existing flushing pumps at Wilmette and 39th streets, and by diversion from the lake through the Chicago River. Experience will dictate just how often and to what extent flushing will be required.

The proper operating routine and plant efficiency and sufficiency will be finally determined by actual operation and field study. In this study, the amount of treatment, the allowable diversion, and the flow of tributaries, as well as the season and the presence or absence of an ice sheet in winter are all factors which must be considered. After facilities for complete treatment have been installed, considerable time may be required to determine their full effect. The required residual dilution will need to be determined, so that reasonable conditions can be maintained throughout the Des Plaines and Illinois River system below Lockport. Judging from past experience, there will be a seasonal and a yearly variation in the needs.



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STARVED ROCK DAM COMPLETED AND POOL FILLED (1933)

CONCLUSION

The works now under construction by the Sanitary District, when put in operation, should be highly beneficial in removing suspended matter and reducing the bio-chemical oxygen demand. The condition of the Des Plaines River below Lockport and the upper Illinois River will depend on the amount of diversion permitted and will vary with the seasons. Study and control under actual operation will be required to determine the final efficiency and sufficiency of the system with a given diversion.

In the lower Illinois River, below Peoria, conditions in the future will be governed largely by the pollution from the Peoria-Pekin metropolitan district. In this section the necessity of reducing the organic load from industry looms large.

ACKNOWLEDGMENTS

The courtesy of Philip Harrington, Chief Engineer, in permitting the use of material from the surveys of the Sanitary District of Chicago is gratefully acknowledged, as is also the assistance of Dr. F. W. Mohlman, Director of Laboratories, who has supervised the sanitary surveys on the Illinois River and the laboratory control of the treatment works.

Design of Modern Suspension Bridges

Simpler Formulas Developed for More Economical Structures

IN the earliest suspension bridges the floors were laid directly on the cables or chains. An American engineer, Charles Finlay, is credited with the introduction, in 1796, of the suspended floor system to provide a level roadway. Excessive vibration of the floor and the imminent danger of overturning by heavy winds led to the development of the stiffening truss, introduced by the elder Roebling in 1855, on the Niagara Falls railway bridge. Analyses of this type of bridge by the elastic theory have resulted in heavy stiffening trusses, safe but uneconomical in design. A deflection theory for simple-span suspension bridges, taking into account the deformed configuration of the structure, was presented by J. Melan in 1888. However, that theory is not directly applicable to bridges with continuous stiffening trusses. To supply this deficiency Dr. Steinman has developed a generalized deflection theory, which is applicable to designs having either continuous or hinged trusses. It yields lower moments and shears and consequent savings, up to 65 per cent, in the weight of metal in the stiffening trusses.

Much has been written on the theory of the stiffening truss, both when continuous from anchorage to anchorage and when hinged at various intermediate points. Dr. Jakkula has reviewed the theories of many investigators and considered the advantages and disadvantages of their methods from the standpoint of theoretical accuracy and workability. He compares the various forms of equations for determining the horizontal component of the cable stress produced by a uniform live load covering any part of the span. The following articles are brief abstracts of the papers presented by Drs. Steinman and Jakkula before the joint session of the Structural Division of this Society and the Applied Mechanics Division of the American Society of Mechanical Engineers on June 30, 1933, during the Annual Convention in Chicago.

The other papers read at this session were sponsored by the Applied Mechanics Division of the American Society of Mechanical Engineers, which will determine their publication and disposition. They are "Impact Effect on Bridges," by Dr. R. Bernhard; "Graphostatics of Stress Functions," by H. M. Westergaard, M. Am. Soc., C.E.; and "The Amplitude of Non-Harmonic Vibrations," by J. P. Den Hartog.

A Generalized Deflection Theory

By D. B. STEINMAN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK, N.Y.

BY an improved and extended mathematical theory for the stress analysis and design of suspension bridges, it is believed that for the first time formulas have been developed which are applicable to the accurate analysis of the various types of suspension bridges, whether hinged or continuous, whether single or multiple span. In the past, most suspension bridges have been designed by an approximate method of analysis known as the "elastic theory." This method, in the derivation of its formulas, disregards the slightly deformed configuration of the structure under loading. Its calculated values for bending moments and shears are too high, satisfying safety but not economy, and its application results in a substantial waste of metal in the stiffening trusses. The error increases with the flexibility of the structure, the span length, and the ratio of dead load to live load.

A more exact method of analysis, which takes into account the deflected configuration of the structure, is called the "deflection theory." It yields lower calculated stresses and a consequent saving, ranging from 20 to 65 per cent, of metal in the stiffening truss. The deflection theory, as applied to non-continuous, single-span suspension bridges, has been available to the profession for over forty years, but an extension of it to include continuous and multiple-span structures has thus far been lacking.

A number of continuous suspension bridges have been built, including the Rondout Bridge at Kingston, N.Y., and the General U.S. Grant Bridge over the Ohio River at Portsmouth, Ohio, with main spans of 705 and 700 ft, respectively. But the more general adoption of the continuous type of suspension bridge, offering advantages of economy and rigidity, has been retarded by the lack of an accurate, scientific theory for its analysis. Similarly, the adoption of multiple-span suspension-bridge designs has been handicapped by the lack of accurate working formulas. Without close proportioning, the full economy of this type of suspension bridge could not be secured.

In order to supply these deficiencies, the author has developed this generalized "exact" or "deflection" theory for suspension bridges, applicable to continuous and multiple-span designs as well as to the simple-span, two-hinged type. The condition of continuity of the stiffening truss at the towers introduced difficulties of mathematical analysis that appeared insurmountable, but these difficulties were finally resolved and practical working formulas were obtained. In several cases, the final working equations and formulas were even simpler and more compact than those previously used for the simple type of suspension structure. To facilitate preliminary or approximate evaluation, still simpler approximate formulas have been developed, and their departure from exact values has been indicated. They also facilitate the interpretation of the mathematical expressions or relations represented.

The formulas derived suffice for the complete and accurate analysis of any standard type of suspension bridge, of any number and proportion of spans, either

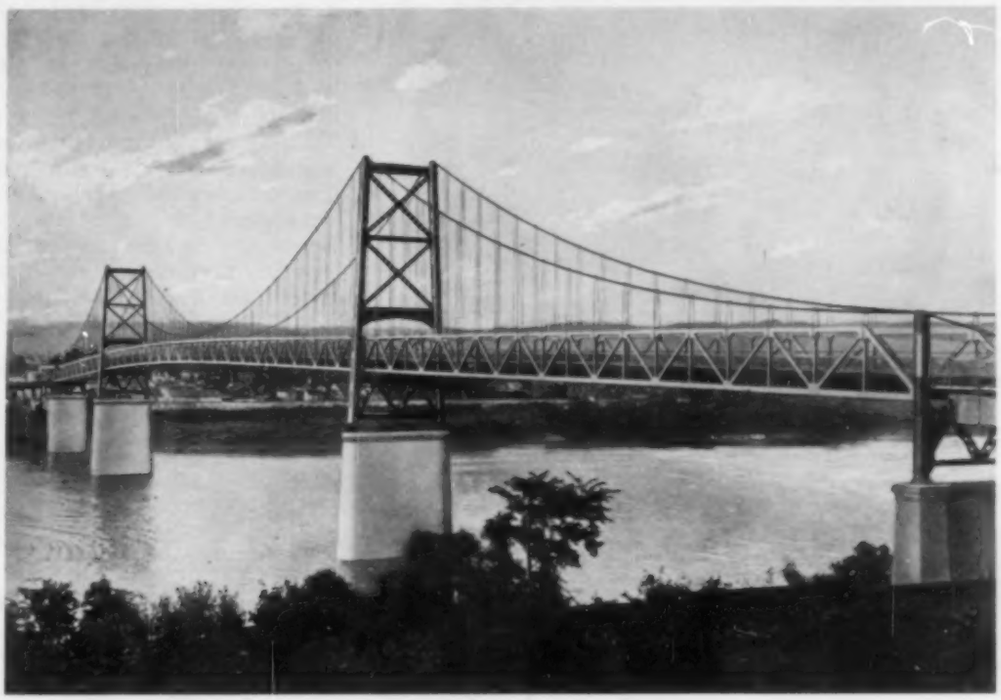
continuous or hinged at the towers. The analysis yields the values for the tension in the cables and the bending moments, shears, and deflections in the stiffening trusses.

TWO EXAMPLES SHOW ECONOMIES

To show the practical workability of the generalized theory a numerical computation has been made, applying the formulas to the analysis of the stresses and deflections in a continuous suspension bridge with a main span of 800 ft. The stresses obtained for the stiffening truss are approximately 45 per cent lower than those yielded by the common elastic theory, representing a corresponding saving of metal that would be impossible if the new theory were not available. The range of savings for continuous suspension bridges is found to be substantially identical with that secured for non-continuous suspension bridges. The percentage reduction or saving yielded by the more scientific deflection theory as compared with the elastic theory is found to be a function merely of the slenderness factor.

The designers of the General U.S. Grant Bridge over the Ohio River (1927), lacking an adequate theory for the exact analysis of the continuous spans, calculated the stresses and sections by the common elastic theory and then assumed a reduction of 10 per cent for the deflection correction. They believed a greater reduction would be justified but had no way of determining the proper amount. Had the present theory and formulas been available, a larger reduction, about 18 per cent, would have been found to be correct. In the design of the Rondout Bridge at Kingston (1932), no reduction was made for the deflection correction, but the newly developed theory shows that an average reduction of 30 per cent in the stresses would have been permissible, with a corresponding saving in the metal of the spans.

Numerical examples in the paper afford a comparison between alternative continuous and non-continuous designs. For a suspension bridge with a main span of 800 ft, the continuous design is found to give 5 per cent more rigidity for the same economy, or 5 per cent more economy for the same rigidity. For shorter spans or heavier structures these percentages of superior efficiency are increased. The general conclusion is, therefore, that the continuous type of suspension bridge offers advantages over the two-hinged type for spans under 1,000 ft when designed for highway loading, and for longer spans when designed for railroad loading.



THE GENERAL U.S. GRANT BRIDGE
A Continuous Suspension Span Over the Ohio River at Portsmouth, Ohio

The availability of this generalized deflection theory should stimulate the adoption and facilitate the economic design of continuous and multiple-span suspension types.

Various Stress Formulas Compared

By A. A. JAKKULA
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FOR a long time the analysis of the stiffened suspension bridge has been recognized as one of the most complicated of structural problems. The complication is caused by the necessity of considering the "deformed" shape of the structure after the action of live load and temperature. This makes the stiffened bridge unique, for in practically all other structures the dimensions before and after loading can be considered the same.

For this comparative study of methods, the type of structure has been selected for which a minimum of algebraic work is required, that is, a two-hinged stiffening truss with unloaded backstays.

Those familiar with the problem of "exact" analysis

of suspension bridges know that the final result in all solutions must be reached by some method of successive approximation. An equation based on the method of

SUSPENSION SPAN OVER THE RIVER TEES, BUILT IN 1741

Melan has been derived, in which the "cut-and-try" procedure is reduced to two steps. The first step gives the horizontal component of cable stress, H, due to a continuous, uniform live load over any part of the span, with an accuracy of $1\frac{1}{2}$ per cent for most conditions of loading, and the second step gives the exact value of the component. The result is obtained by arranging the solution for H in the form of a quadratic equation in which all the factors that make the "cut-and-try" procedure necessary appear in two terms. If these two terms are considered equal to zero in the first approximation, the equation is directly solvable for H. For a structure of long span this first value of H is accurate within $1\frac{1}{2}$ per cent. In the second step this value of H is used to obtain values for the two terms previously mentioned. When they are evaluated, the equation gives values of H that are for all practical purposes exact.

The method of Melan assumes that the live load can be considered as producing a uniform stress in the hangers. The error in this assumption has been recognized for a long time as being slight, but little numerical evidence has been produced to show its magnitude. An analysis of the Ambassador Bridge, using the trigonometric series form of solution developed by S. Timoshenko, shows that this error is about 1 per cent.

A careful study of the series solution shows that a method can be developed by which the "cut-and-try" work is reduced to a minimum. At least five terms in the series must be used to obtain results comparable to those secured by the Melan method.

For a long time it has been felt that an influence-line solution for the stiffened suspension bridge was impossible, but this feeling is perhaps unjustified. Two solutions for a concentrated load placed at any point in the span are developed, and influence lines for H are drawn. In the first solution the actual distribution of the concentrated load to the cable is neglected, but in the second this factor is considered. The results from the influence line based on the second solution compare well with results from the other solutions.

The various methods presented have been compared by means of an analysis of the Ambassador Bridge, using ten increments of live load ranging between 0 and 2,000 lb per ft and six different positions of the live load on the span. The solutions obtained for the 60 different loading conditions include the horizontal component of the cable stress and the deflections of the truss. The conclusions, therefore, are based on an analysis of one of the longest structures in the world. It is believed that they are general but it is realized that an analysis of a short-span bridge might alter some of those based on numerical results.

The main conclusions are:

1. The equation for H based on the Melan method is very workable and when used in the way indicated will give in two steps values for H as exact as is ever necessary. It will give in one step results suitable for estimating costs, in which all "cut-and-try" methods are unnecessary.

2. The advantages and disadvantages of the Melan method and the series method of analysis can be summarized as follows: (*a*) The complete derivation of the equations for deflection and for H is a great deal easier and quicker by the series method than by the Melan method. (*b*) In a numerical problem the use of the Melan equation for H is simpler than is the series solution. (*c*) When H has been evaluated numerically in any given case, the deflections, moments, shears, and actual load division between cable and truss can be found more readily by the series, than by the Melan, method. (*d*) The series method is the only practical way to find the effect of the actual load distribution.

NIAGARA FALLS RAILROAD BRIDGE, BUILT IN 1855
An Early Stiffened Suspension Span

3. All the data obtained tend to prove that it is not necessary to consider the actual distribution of the live load to the cable when uniform loads are used.

Keeping Our Streams Clean

Extensive Studies Indicate Means of Relieving a Serious Condition

HOW to dispose of industrial and municipal wastes has become a grave problem, and when the disposal is by discharge into streams it is a problem of the first magnitude. Such disposal adversely affects public health and public comfort. It may destroy fish and shellfish and may render the water unfit for domestic, industrial, and agricultural use. Wasted oil also creates a serious fire hazard at docks and harbors. Studies reveal that the by-products obtained by treating objectionable wastes are often valuable enough to pay the cost of the installation required for treatment. On June 30, 1933, at the Annual Convention of the Society in Chicago, the Sanitary Engineering Division devoted considerable time to the presentation of papers on various phases of this important subject. The high lights of these papers are here abstracted.

The Problem of Stream Cleansing

By ALMON L. FALES

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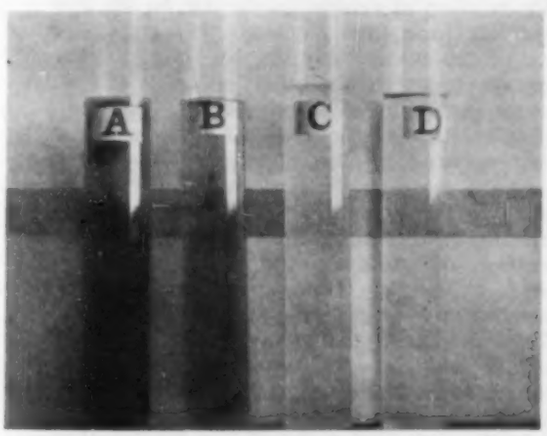
FORMERLY streams were looked upon as a means provided by Nature for the disposal of filth and refuse of all kinds. The installation of community water supplies and the inadequacy of cesspools led to the construction of sewers or sewerage systems emptying into nearby streams. With the growth of communities and industries, many streams have become seriously polluted.

EFFECTS OF POLLUTION

The pollution of waters has several important aspects, among which may be mentioned: (1) public health, particularly in relation to the contamination of waters used for domestic water supply, bathing, or shellfish culture; (2) public comfort, largely as regards conditions objectionable to sight or smell, rendering the waters unattractive or unfit for recreational uses, or even creating a nuisance; (3) commercial factors, chiefly the effect on fish life and on the use of the waters for agricultural or industrial purposes; and (4) navigation, as relates to deposits causing obstruction to shipping or the presence of objectionable substances, such as acids that are damaging to vessels, and oil which creates a fire hazard at the docks.



REPRESENTATIVE SAMPLES OF TANNERY WASTE DURING TREATMENT

A. Crude Tannery Waste. B. Settled Waste. C. Chemical Effluent. D. Filter-Bed Effluent. E. Not shown, Taken from the Brook Above Treatment Plant, Has Appearance of Sample D

Formerly it was believed that the waters of a flowing stream became purified in traveling a short distance. It is now understood that although a rapid rate of flow is advantageous for the prevention of putrefaction in heavily polluted waters, sewage bacteria may be carried long distances by rapidly flowing streams. Storage in ponds on a stream is beneficial in reducing the number of these bacteria, not only by subsidence but also by the death of the bacteria during the storage period afforded.

In the self-purification of polluted streams under aerobic conditions, that is, in the presence of oxygen, bacterial oxidation of the organic matter takes place, creating a demand upon the dissolved oxygen of the waters of the stream. If the oxygen available becomes exhausted, anaerobic decomposition, or putrefaction, sets in and offensive odors are produced. It is therefore important to maintain aerobic conditions to prevent the stream from becoming a nuisance. At winter temperatures, near the freezing point, very little bacterial action takes place and consequently there is very little oxygen demand. As the temperature increases, bacterial action and the oxygen demand increase to a maximum in the summer. The sedimentation of sewage matter in sluggish streams or ponds reduces the current oxygen demand, but accumulations of sludge deposits not flushed out by the flood flows in the spring will exert a high oxygen demand in summer. Such deposits are frequently the cause of offensive conditions.

Dissolved oxygen derived from the atmosphere is the major source of the oxygen supply. The solubility of atmospheric oxygen in water decreases with increasing temperature. The amount found is commonly expressed in percentage of saturation at the particular temperature. As the dissolved oxygen is reduced below the saturation point, the water takes up oxygen from the air by re-aeration. Agitation of the water facilitates the absorption of oxygen from the air, and the rate of absorption increases with the degree of turbulence.

In a polluted stream with a high oxygen demand, the dissolved oxygen continues to decrease in spite of re-aeration as the water passes downstream. However, a point is reached below which the rate of absorption of oxygen by re-aeration exceeds the rate of depletion of dissolved oxygen. This is called the critical point. To

maintain aerobic conditions in a polluted stream, it is only necessary to have sufficient oxygen available to satisfy the oxygen demand until the critical point is reached.

TREATMENT OF POLLUTED STREAMS

It is not generally practicable to solve problems of stream cleansing by treating the polluted waters, but in some cases objectionable conditions may be alleviated by such means. Improvement may be effected by utilizing or constructing reservoirs above the point of pollution for the storage of water during periods of relatively high stream flow in the winter and spring, and for the regulated withdrawal of the stored waters during the summer and fall. In the Ruhr district in Germany, the self-purification of polluted streams is aided by the construc-

SEWAGE POLLUTION OF MIAMI RIVER, AT DAYTON
Before Construction of Treatment Works

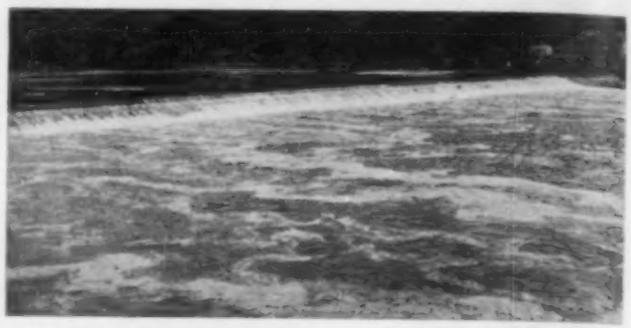
tion of reservoirs on the streams below the points of pollution. These artificial lakes increase the time of flow and permit correspondingly greater bacterial oxidation of organic matter. The sludge deposits must be dredged out from time to time. In the Emscher district in Germany large settling basins have been built for the entire river, the sludge being removed by dredges and pumped to lagoons.

In some cases sodium nitrate solution has been added to heavily polluted waters during critical periods to furnish a supply of available oxygen when the dissolved oxygen was exhausted. Chloride of lime has been applied to heavily polluted ponds when they became black and foul and created offensive odors due to putrefaction. Chemicals have also been applied to streams for the destruction of excessive organic growths. During 1930, a study was made of the effect upon Bolin Creek of chlorinating the settled sewage from Chapel Hill, N.C., which showed that this treatment caused a marked improvement in the physical appearance of the stream, allayed obnoxious odors, partially stabilized the organic matter, retarded bacterial activity, and destroyed a large part of the bacteria in the stream.

TREATMENT OF SEWAGE AND INDUSTRIAL WASTES

It is necessary to discharge sewage and industrial wastes into some stream or body of water after such treatment as may be required. It is now possible to treat sewage to almost any desired degree. Many kinds of industrial waste are susceptible of treatment by established sewage treatment processes, with or without modification. For some kinds of industrial waste radically different methods of treatment are required. In connection with the treatment of industrial wastes, the possibility of the recovery of by-products should not be overlooked. The degree of treatment required for sewage and industrial wastes depends upon local conditions, including the character of the stream, the extent of dilution, and the subsequent uses of the waters.

In cases where the sewage or treatment-plant effluent is discharged into a lake, a harbor, or the open sea, factors other than dilution must be considered, such as the



GLUE FACTORY WASTES RUIN APPEARANCE OF RIVER BY FORMATION OF SCUM

effects of temperature, winds, tides, and currents. Outlets should be so located that the sewage or effluent will become sufficiently dispersed to prevent objectionable pollution of shore waters. Even though the degree of dilution is very great, the sewage must be sufficiently treated so that floating matter will not be carried to the shore by winds and currents.

In the case of tidal estuaries, the tidal prism, or volume of water included in a section between high and low tide, contributes to the flow from the land for purposes of dilution. On the other hand, the flood tide promotes sedimentation of sewage solids and, in the case of comparatively long tidal streams, the shunting back and forth of the sewage mixture by the tides may greatly delay its passage to the open sea. The salt water tends to cause precipitation of finely divided suspended matter and to increase the hydrogen sulfide gas, or rotten-egg odor, produced by decomposition. The decomposition of sewage matter deposited over considerable areas in shallow tidal waters may give rise to very offensive odors. Lowering of the water level at ebb tide promotes the liberation of gas from the decomposing solids. The discharge of sewage effluent into tidal estuaries therefore constitutes a special problem.

There is a marked difference in the character of streams that are unaffected by tides. Some have a rapid uninterrupted flow and others have a sluggish flow, or are ponded to a considerable extent. Some have a comparatively short time of flow before receiving the waters of sizable tributaries or discharging into relatively large streams or bodies of water. Others have a comparatively long time of flow before the stream is substantially increased. These factors have an important bearing on the degree of sewage treatment required.

Early investigations of polluted streams by Hering, Stearns, Hazen, Goodnough, and others, led to the conclusion that dilution ratios of 3.5 to 6 cu ft per sec of diluting water per thousand of population contributing sewage are commonly required to prevent a nuisance. If the stream flow is less than 3.5 cu ft per sec per thousand population, a nuisance is likely to result. If the flow is more than 6 cu ft per sec no offense is to be expected unless the waters are affected to a considerable

extent by other sources of pollution. Local conditions must be taken into consideration in each case, and the rights of others in utilizing the diluting power of the stream must not be overlooked. To avoid a nuisance the sewage must be treated to such extent as necessary to prevent the exhaustion of dissolved oxygen in the receiving waters.

In order to support fish life the load of decomposable organic matter must not be so great as to reduce the dissolved oxygen content of the waters much below 3 ppm, equivalent to approximately 33 per cent of saturation at 20 C (68 F). Waters to be used for fishing obviously must not be polluted with any substance of such kind and in such amount as to kill the fish or destroy the living organisms on which their life depends.

Regardless of the amount of dissolved oxygen present in a stream, if it is to be attractive for boating and for scenic beauty it must not be polluted to such an extent as to materially affect its color, turbidity, suspended matter, or other physical characteristics. It must also be free from disagreeable odors. A high degree of treatment of sewage and industrial wastes may be required to prevent such objectionable conditions.

No sewage pollution in the immediate vicinity of bathing beaches should be permitted. Physical evidence of sewage pollution should not be tolerated, even though the sewage matter has been brought considerable distances by winds and currents. Bathing waters not only should be clean in appearance and contain no objectionable substances from industrial wastes, but also should be reasonably free from bacteria of known sewage origin.

There is no generally accepted bacteriological standard for natural bathing waters, and there is insufficient epidemiological evidence for the determination of such a standard.

If sewage is discharged into sources of public water supply, the stream must be such that, with the minimum dilution afforded, no hazard will result in the use of the water after treatment. Studies by the U.S. Public Health Service based on Ohio River treatment plants, indicated that the maximum degree of bacterial pollution of raw water consistent with the production of a filtered and chlorinated water conforming to the revised U.S. Treasury Department standard for drinking and culinary water supplied by common carriers, is represented by a B. coli index approximating 5,000 per 100 cc. Subsequent studies indicated that with certain combinations of treatment, the B. coli index of the raw water might be increased to as many as 60,000 per 100 cc.

Even in the case of treatment plants accomplishing efficient disinfection of sewage, a high dilution is required if the disinfected sewage is discharged into a source of public water supply. Sewage may be sterilized so as to conform with the bacterial standard of the U.S. Treasury Department, but obviously such sterilized sewage would not be suitable to drink even after treatment by a modern water purification plant. The Treasury Department has adopted standards (1) as to source and protection, (2) as to bacteriological quality, and (3) as to physical and chemical characteristics.

Although the effects of industrial wastes on water supplies are more varied, and in many cases more serious, than are those of domestic sewage, water supplies can receive a limited amount of some wastes without overloading water purification plants or seriously affecting the quality of the effluent. When the amount or character of the industrial wastes is such as to render it impracticable or unreasonably expensive to produce a satisfactory water, the industrial wastes must be satisfactorily treated or even eliminated unless it is expedient to secure a more satisfactory source of water supply.

NATIONAL INDUSTRIAL RECOVERY ACT FUNDS AVAILABLE

Much progress has been made in the treatment of sewage and industrial wastes to abate stream pollution, but many streams are still in a seriously polluted condition. The present is a favorable time to proceed with projects for stream cleansing. The costs of labor and materials are low. Such projects will afford a measure of relief for unemployment and may be financed in such a way as to avoid an increase in the tax rate. Advantage can be taken of the National Industrial Recovery Act, of which Title II, "Public Works and Construction Projects," provides financial aid, including outright grants of 30 per cent of the cost of labor and materials. Among the projects eligible for such Federal aid are those for "conservation and development of natural resources," including "purification of waters." The utilization of the benefits of this act, for the construction of needed projects, is also considered a public duty, to stimulate the recovery of business.

Relative Importance of Industrial Wastes in Stream Pollution

By L. F. WARRICK

STATE SANITARY ENGINEER, WISCONSIN STATE BOARD OF HEALTH, MADISON

TREMENDOUS strides forward in the manufacture of the various commodities that have become a part of our modern civilization have marked "A Century of Progress in Industry." In the phenomenal development of mass production in this country, efficiency in the utilization of raw materials has often been sacrificed in the effort to speed up the wheels of industry. Particularly was this true during the World War. Industrial wastes were looked upon as a necessary evil. The most convenient and cheapest method of getting rid of them was sought, and in many cases this appeared to be dumping into the nearest watercourse. Accordingly, with expanding manufacturing activities, the present-day problems of pollution by industrial waste grew steadily worse.

The public has become increasingly aware of the harmful effects of unrestricted stream pollution. The uses of natural waters for drinking and domestic purposes; for industrial water supply; for watering of stock; for propagation of fish, oysters, and other aquatic life; for navigation; for power production; for agricultural development involving irrigation; and for recreational purposes, including bathing, boating, and fishing, particularly for game fish—all these uses have been ad-

versely affected in some degree by utilizing the same waters for the disposal of sewage and industrial wastes. In some cases streams have been so polluted as to make them absolutely unfit for normal uses. The result has been a growing demand, particularly during the past fifteen years, that our natural waters be kept in a reasonably clean condition.

Public demand for clean streams in this country is reflected in the legislation enacted by many states and by

A STUDY OF THE EFFECT OF INDUSTRIAL WASTE ON FISH
Conducted by the Wisconsin State Board of Health in the Sanitary Engineering Laboratory at the University of Wisconsin

the Federal Government. At first such legislation tended to be absolutely prohibitory in nature, such as the Oil Pollution Prevention Act passed by Congress in 1924. Numerous damage suits arising from unrestricted pollution of streams have been instituted and in many cases the courts have upheld the rights of riparian owners under the common law to receive the waters of streams flowing through their property "undiminished in quantity and unimpaired in quality."

Experience has shown, however, that law enforcement alone does not provide the solution of many problems of pollution by industrial wastes. There are technical and economic, as well as legal, aspects to be considered. Accordingly the trend, particularly during the past decade, has been toward the establishment of governmental, industrial, and other agencies to undertake cooperative studies, to work out suitable means of reducing these wastes to a minimum, and to bring about the necessary stream improvement.

TODAY'S WASTES BECOME TOMORROW'S PROFITS

The Sanitary Water Board of Pennsylvania and Illinois, the Michigan Stream Control Commission, and the State Committee on Water Pollution of Wisconsin are examples of state bodies created to secure the abatement of pollution. The Ohio River and Great Lakes Board of Public Health Engineers are typical agencies developed to permit the states within these two major drainage basins to work out comprehensive cooperative programs for reducing the pollution of interstate streams, assisted by the U.S. Public Health Service.

Industrial groups are becoming increasingly aware of the advantages of collective action in solving some of their common problems of waste utilization or disposal, as evidenced by the employment of engineers especially for this purpose by such organizations as the American Pulp and Paper Association and the American Petroleum Institute. There is already much evidence to show that the programs adopted by these various agencies are producing definite results and are materially beneficial in cleaning up the lakes and streams of the country.

The general policy underlying the various programs through which these results are being obtained calls for: (1) waste utilization to the greatest possible degree, and (2), if a pollution problem still exists, installation of any effective and practical method available or capable of being developed to treat and dispose of the waste in a satisfactory manner. With certain wastes, such as those produced in pulp and paper mills and in corn products plants, it has been found that by carrying waste utilization to its economic limits, pollution problems have been entirely eliminated or greatly minimized. It has been found in these cases that the value of the materials recovered far exceeds the cost of installation and operation of the recovery systems. Progress made in the past few years substantiates the truth of the adage, "From the wastes of today will come the profits of tomorrow."

POLLUTING EFFECTS OF INDUSTRIAL WASTES

In considering the disposition of industrial wastes, the various agencies of government, industry, and the public in general frequently have quite different ideas as to the relative importance of the wastes in stream pollution. This is to be expected, since there are elements peculiar to each individual situation, and the same measuring stick is not applied by all concerned. On the basis of appearance it may seem to non-technical people that a spent dye solution brings about vastly worse pollution than a relatively clear and colorless waste which is highly acid or caustic, or contains ingredients capable of causing much more trouble when considered from other points of view. The public interests involved may vary markedly. Therefore some reasonably acceptable classification of industrial wastes according to their relative importance in stream pollution must necessarily be established on a definitely specified basis, and some satisfactory unit or standard must be agreed upon for comparing different wastes.

The uses of streams previously mentioned have been taken as a fundamental consideration in any such classification. The polluting strength of trade wastes as affecting a given use have been evaluated through suitable analytical procedures, results being compared on the basis of some common unit. This comparison may be based on the type and amount of solids content, on the bio-chemical oxygen demand, or on any other convenient determination of significance as regards stream use.

That there is no one unit which tells the whole story for a given stream use is well illustrated by some of the studies conducted in Wisconsin by the State Board of Health to determine just how wastes from pulp and paper mills may interfere with the use of a stream for the propagation of fish. It is fairly well known that fish may be affected by pollution in any or all of the following ways: (1) direct killing through toxic constituents; (2) changes in natural conditions, such as depletion of dissolved oxygen, so that fish seek another habitat either because of the condition of the water or the effect the wastes have on plants or lower animal life constituting their food; and (3) interference with the development of fish life and young fish, that is, influence on the reproduction of the species.

In comparing sulfite and sulfate pulp-mill waste liquors it was found that a direct toxic effect on the game fish used in the experiments might be expected when the wastes were diluted less than one part in 200 by volume. The wastes did not differ greatly with respect to the degree of dilution required to avoid destruction of fish by their poisonous constituents, presumably mercaptans or sulfur compounds. However, the sulfite wastes had a

much greater avidity for oxygen than the sulfate wastes. Since these sulfite and sulfate wastes would probably deplete the dissolved oxygen in a stream below the critical amount necessary to sustain fish life before the limiting dilution of one part in 200 for toxic effects was actually reached, the most significant basis of comparison is their oxygen demand. Their relative effect on fish foods or reproduction of the species cannot be readily measured with our present knowledge.

If these wastes were compared according to their suspended solids or pulp fiber content, there would be practically no difference between them. Tests described in the 24th Annual Report (1932) of the Engineering Society of Wisconsin indicate that pulp fiber does not ordinarily accumulate in, and clog the gills of, fish causing death by suffocation. There is, however, the possibility of an indirect effect if fibers and other solids settle to the bed of a stream and decompose there, using up the dissolved oxygen necessary to support fish and other aquatic life.

OFFENSIVENESS OF INDUSTRIAL WASTES MEASURED

Probably the most common pollution characteristic of industrial wastes is an affinity for oxygen. This may be a chemical or a biological oxygen demand, or a combination of both, depending on the nature of the waste. As the depletion of dissolved oxygen in a stream generally causes a nuisance, the bio-chemical oxygen demand of industrial wastes may be regarded as a measure of their degree of offensiveness. Accordingly the 5-day bio-chemical oxygen demand determination has come into widespread use for evaluating "offensive" pollution occasioned by both domestic sewage and trade wastes.

Although the application of this test to some wastes is of questionable value or is known to give somewhat misleading results as compared with the standard methods for measuring the strength of sewage, modifications in technique will gradually overcome these difficulties. Further studies in this field are needed to ensure that the results obtained by different laboratories making tests on trade wastes will be strictly comparable.

In investigations of stream pollution, it is frequently advantageous to convert the data on the oxygen demand of industrial wastes into "population equivalents" in order to reduce the polluting ability of the wastes and that of the domestic sewage to a common, readily understandable basis. These population equivalents are obtained by dividing the total daily oxygen requirement of the waste under consideration by the daily per capita oxygen demand of the domestic sewage. On the basis of a 5-day bio-chemical oxygen demand, this amounts to 0.167 lb of oxygen. Total oxygen requirements are further broken down to show population equivalents per unit of raw material or finished product, as shown in Table I. This table presents the average results of surveys on polluting wastes from pulp and paper mills in Wisconsin for 1929, 1931, and 1932, grouped as to type of mill.

TABLE I. POPULATION EQUIVALENTS PER UNIT OF PRODUCT
Based on Values for 5-Day Bio-Chemical Oxygen Demand of Pulp and Paper Mill Wastes

TYPE OF MILL	UNIT	POPULATION EQUIVALENTS
Paper mills	Ton of paper	30.5
Sulfite pulp and paper mills	Ton of paper	1,600.0
Groundwood pulp and paper mills	Ton of paper	19.7
Kraft pulp and paper mills	Ton of paper	332.0
Sulfite pulp mills	Ton of pulp	1,650.0
Groundwood pulp mills	Ton of pulp	39.7
Kraft pulp mills	Ton of pulp	393.0

Pulp and paper mills are rated as to their production. On the other hand, milk plants are rated on the basis of their milk intake. In Table II the unit taken for the various types of dairy product establishments in presenting average population equivalents is 1,000 lb of milk taken in per day, based on composite samples of waste discharged throughout a working day. Further studies may modify these values.

TABLE II. POPULATION EQUIVALENTS PER UNIT OF RAW MATERIAL
Based on the 5-Day Bio-Chemical Oxygen Demand of Milk Plant Wastes

TYPE OF PLANT	UNIT IN POUNDS OF MILK INTAKE	POPULATION EQUIVALENT
Condensery	1,000	4.8
Cheese factory (washings and some whey)	1,000	16.1
Receiving station	1,000	2.8
Milk bottling plant	1,000	4.7

It is sometimes a good plan to separate wastes within a given mill or industrial plant in order to show their relative pollution strengths, and also to indicate the advantages that may accrue from utilization rather than treatment and disposal of some of the stronger wastes.

HEALTH ASPECT OF POLLUTION BY INDUSTRIAL WASTES

From the point of view of the public health, the greatest danger from industrial wastes, is their effect on public water supplies. It is generally recognized that the most important use of a stream is as a source of public water supply. Any pollution which interferes materially with the quality of the water furnished the consumer, such as that occasioned by trade wastes containing phenols, tarry acids, and similar compounds, should be abated with the minimum of delay. Phenols present in quantities as small as one part per billion are reported to cause tastes and odors in water supplies treated with 0.5 part per million of chlorine. These tastes and odors have frequently provoked the water users to obtain drinking water from sources of unknown or questionable purity, resulting in some instances in severe outbreaks of water-borne diseases, such as epidemics of typhoid fever.

TREATMENT PLANT FOR MILK WASTE IN WISCONSIN
(*a*) Flow Equalizing and Secondary Settling Tanks; (*b*) Pump House; (*c*) Biological Filter Equipped with a Rotary Distributor, Found Effective in Solving Problems of Milk-Waste Pollution

FURTHER STUDY OF PROBLEM RECOMMENDED

From this discussion it will undoubtedly be concluded that the classification of industrial wastes according to their relative importance in stream pollution is impractical unless the uses of the stream are taken into con-

sideration. The technique of bio-chemical oxygen demand determinations to evaluate the requirements of the various trade wastes needs further study. This applies also to other methods of analysis, in order to show on a comparable basis the pollution characteristics of wastes other than the oxygen demand.

In conclusion, extension and further development of the cooperative policies and procedures inaugurated by government, industry, and others concerned is urged to the end that the most effective and economical solutions for problems of industrial waste may be speedily and satisfactorily found.

Decatur Cleanses the Sangamon River

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THE Sangamon River, the largest tributary of the Illinois River, has a total drainage area of 5,673 sq miles, which is divided between the main river and its two principal branches as follows: Sangamon River, 3,159 sq miles; Salt Creek, 1,568 sq miles; and

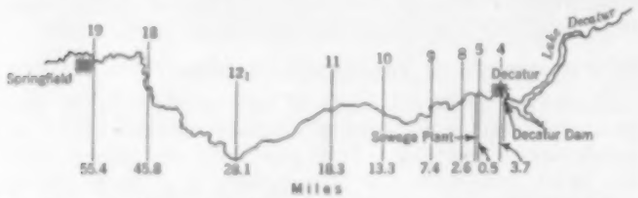

FIG. 1. THE SANGAMON RIVER, DECATUR TO SPRINGFIELD, ILL. Location of Sampling Stations Indicated

South Fork, 946 sq miles. The river rises in Champaign County, Illinois, and passes through the cities of Mohomet, Monticello, Decatur, Springfield, and Petersburg, Ill. [as shown in the map on page 485].

During 1912 and 1913 the Illinois State Water Survey made a very complete study of the pollution of the Sangamon River, as reported in its Bulletin No. 11. It made specific recommendations in regard to the treatment of the sewage and industrial wastes at Decatur, and predicted that Springfield would have to treat its sewage within ten years. At that time the river below Decatur was grossly polluted and did not return to normal for 15 or 20 miles below the city. A very complete biological investigation of the Sangamon River from Mohomet to Springfield, made by the Illinois State Water Survey during 1918 and 1919, showed that the river was grossly polluted 30 miles below Decatur, and revealed evidence of pollution due to the severe winter of 1917 all the way to Springfield, a distance of about 55.4 miles.

DECATUR'S SEWAGE TREATMENT PLANT

The first definite step toward solving the pollution problem was the organization of the Decatur Sanitary District in 1917. Construction of a sewage treatment works was delayed because of the World War. The first installation, consisting of grit chambers, Imhoff tanks, sprinkling filters, and secondary tanks, with a capacity for 60,000 population was completed and placed in operation in the summer of 1924. A detailed description of the pollution problem at Decatur, Ill., and the successive steps taken in its solution is to be found in TRANSACTIONS, vol. 94 (1930).

During the period of construction the phenomenal growth of a local starch and glucose works increased the average strength of the sewage and trade waste mixture to the equivalent of more than 300,000 population. After two years of study with the aid of a large testing station, the capacity of the plant was increased to care for an equivalent population of 150,000 by introducing a partial activated sludge treatment between the Imhoff tanks and the dosing tanks. This plant was called the "pre-aeration plant" and was completed on December 31, 1927. During its construction the starch industry changed its manufacturing processes so that the average population equivalent of the combined sewage and waste has been less than 120,000 since July 1928.

These combined efforts made possible the complete treatment of the sewage-waste mixture, except for overflows due to storms and for periods of high water which put the sprinkling filters out of operation for about three months in years of normal rainfall. In 1930 a pumping station was built to discharge the final effluent into the river during periods of high water so that the sprinkling filters can now be operated 365 days a year. In 1932 a storm-water treatment tank was constructed which gives a 30-min sedimentation period to storm water when the total sewage flow is more than four times the dry weather flow or 40 mgd. A separate heated sludge digestion tank and a sludge storage tank were also constructed to digest the storm sludge and to re-

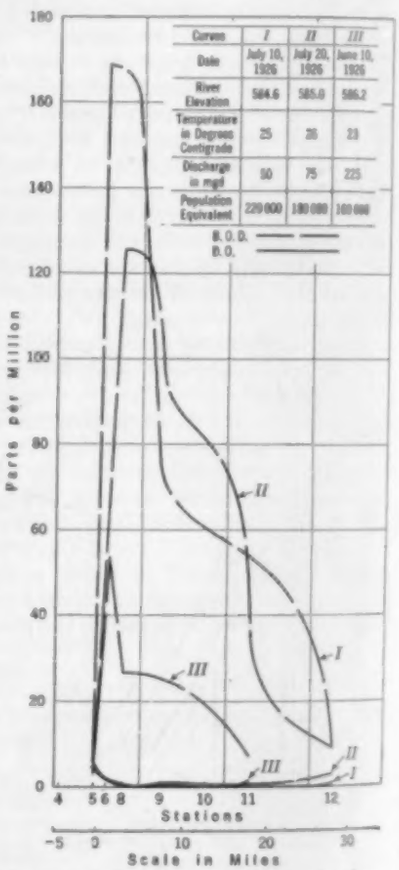

FIG. 2. RESULTS OF SOME BIO-CHEMICAL SURVEYS OF THE SANGAMON RIVER BELOW DECATUR, ILL. Made During 1926, Before Complete Treatment of Sewage Was Instituted at Decatur

lieve the Imhoff tanks which were overcrowded badly.

The river is now protected by complete treatment of the dry-weather sewage flow all the year round, by complete treatment of almost twice the dry weather flow in time of storm, and by sedimentation of excess storm water up to a total of 40 mgd. The treatment removes from 90 to 95 per cent of the bio-chemical oxygen demand and the bacteria in winter and summer, respectively, and produces an effluent containing between 10 and 20 ppm of bio-chemical oxygen demand and 5 ppm of nitrates.

PRESENT CONDITION OF THE RIVER

Above Decatur, Ill., the Sangamon river has a drainage area of 862 sq miles. Here a water supply dam forms an impounding reservoir 12 miles long and about half a mile wide. During years of normal rainfall (a mean of 35 in.) water flows over the dam except during dry summer periods, usually August and September. During the drought years of 1931 and 1932 no water passed over the dam, which is four miles above the treatment plant, during periods of four and five months, respectively. During these dry periods 3 mgd of water seeped under the dam, and this was practically all the dilution afforded the effluent from the sewage plant for many miles downstream because all the creeks and small branches of the river were practically dry. It is thus evident that during such periods the flow below the sewage treatment plant for from 20 to 30 miles has been made up of approximately 10 mgd of sewage or treated effluent and 3 mgd of dilution water.

Below the sewage treatment plant the river follows its normal tortuous channel for 10.4 miles, then enters a canalized section about 18.5 miles long, and next proceeds in its normal course for 26.5 miles to the Springfield water works dam, a total distance of 55.4 miles. The normal river channel is a series of deep and shallow stretches, which in times of low water are separated by riffles, thus affording both sedimentation and aeration. In the canalized section the velocities vary from $2^1/_2$ times the uncanalized flow to higher values at higher river discharges, so that there is little sedimentation but considerable aeration. In dry weather the only tributary of any size below Decatur is the South Fork, which enters 41 miles below the city's sewage treatment plant. The flow of the tributary is about one-third that of the river at this point. In Fig. 1, a map of the river between Decatur and Springfield, are indicated the sampling points used in the surveys of the stream. This map was copied from the advance sheets of an investigation made in 1928 by the U.S. Geological Survey.

Surveys of the stream between Decatur and Springfield were started early in 1926 when the river was in a septic condition for 10 to 30 miles below Decatur. At this time only tests for dissolved oxygen and bio-chemical oxygen demand were made. In later surveys these tests were supplemented by bacteriological tests for total bacteria per cubic centimeter at 37 C and by presumptive tests for B. coli in standard lactose broth.

In Fig. 2 are shown graphically the results of some of the surveys made in the summer of 1926, before the maximum flood in the fall of the same year. These data indicate the gross pollution of the stream in 1926, when the sewage plant was settling most of the sewage and treating only about one-third of the settled sewage on the sprinkling filters. Data on the elevation and discharge of the river, the temperature of the water, and the population equivalent of the sewage and effluent entering the river are given for each set of curves.

During this period the population equivalent of the crude sewage was between 250,000 and 350,000 and that of the combined filter effluent, Imhoff tank effluent, and by-passed sewage varied from 150,000 to 250,000. The worst condition of the river is shown by curve *I* in Fig. 2, which represents conditions when the strength of the wastes entering the river was equivalent to a population of 220,000. At that time the total discharge of the river was 50 mgd, including 10 mgd of sewage discharged into it. Thus the total dilution of the plant effluent

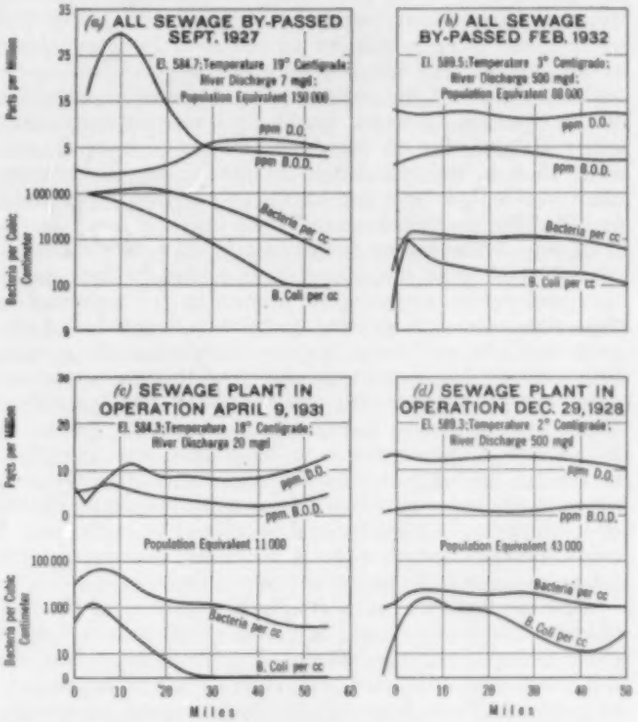

FIG. 3. RESULTS OF BACTERIAL AND CHEMICAL SURVEYS MADE BELOW DECATUR FROM 1927 TO 1932, UNDER VARYING CONDITIONS OF FLOW AND TREATMENT OF SEWAGE EFFLUENT

was 1 to 5. Under these conditions the maximum bio-chemical oxygen demand (for 5-day incubation at 20 C) in the river was 168 ppm. This dropped rapidly for 30 miles downstream. The stream was septic for the whole 30-mile stretch, at the lower boundary of which dissolved oxygen just began to appear. A positive oxygen balance is indicated shortly below this point. At the higher stages the contributory population was greater because the sprinkling filters had to be by-passed. Except at the highest river elevation, a positive oxygen balance was not reached for 15 or 20 miles below the plant. These curves give a good picture of the foul condition of the Sangamon River for 15 to 30 miles below the Decatur sewage treatment plant during the summer of 1926.

SURVEYS SINCE JANUARY 1928

The curves in Fig. 3 (*a*) and (*b*) illustrate the condition of the river in September 1927 and again in February 1932, when the entire sewage flow was by-passed to the river. These curves include the total bacteria counts and presumptive tests for B. coli, plotted to a logarithmic scale which greatly dwarfs the high counts. The curves in Fig. 3 (*a*) are comparable with those in Fig. 2 except that the data for the latter cover a distance of 55 miles downstream. Here again an oxygen balance was not reached for almost 30 miles below the treatment plant. The total bacteria count was reduced from 1,000,000 to 5,000 per cc in the 55.4 miles between the Decatur plant outlet and the intake of the Springfield water works,

while the B. coli count per cubic centimeter was reduced from about 1,000,000 to 100.

The condition of the river when it was discharging 500 mgd over the Decatur Dam is shown in Fig. 3 (*b*). At this time all the sewage had been by-passed for about ten days. However, because of the processes of waste recovery used at the starch works the population equivalent of the by-passed sewage was only about 88,000. At this dilution—1 to 50, plus additional drainage water all the way downstream—and the reduced strength of the sewage, the oxygen balance in the river is satisfactory at all points. At the low temperature, 3 C, and the higher velocity of the river, the total bacterial pollution at the Springfield water works 55.4 miles downstream was still 5,000 per cc, of which 100 per cc were B. coli even though the maximum counts below the sewage plant were only 20,000 and 10,000, respectively, compared to 1,000,000 in the curves in Fig. 3 (*a*).

In Fig. 3 the curves in (*c*) and (*d*) are directly comparable with those in (*a*) and (*b*) in regard to river elevation and temperature. The curves in (*c*) represent a time when the sewage was completely treated and the river was low, and those in (*d*) a time when the sewage had received sedimentation and pre-aeration treatment only, except that on the previous day the sprinkling filters were placed in operation after a 15-day period of high water. The curves in (*c*) show that, with complete treatment and a low dilution of 1 to 3, the bacteria count in the river is reduced from a maximum of 70,000 to 1,000 per cc in 35 miles and to 500 per cc in the next 5 miles; and further, that the B. coli count is reduced from a maximum of 2,000 per cc to 1 per cc in 30 miles.

A satisfactory excess of dissolved oxygen over the bio-chemical oxygen demand is found at all points, except three miles below the plant. At this point, when the dissolved oxygen is at 3 ppm, the stream is apparently in good condition, although the bio-chemical oxygen demand is 5.5 ppm. This drop in dissolved oxygen below that present in the first two or three miles below the treatment plant is quite characteristic of all the surveys made at summer temperatures and low river stages.

The curves in Fig. 3 (*d*) show the effect of three interesting conditions: (1) high water, which increases the velocities in the channel and carries the bacterial pollution farther downstream before the organisms can die off; (2) a low temperature, which tends to preserve the biological equilibrium and thus maintain the bacterial count at a high point; and (3) the higher population equivalent of the plant effluent because the sprinkling filters were below the river level and therefore out of service. The oxygen balance in the stream was most satisfactory, but the total reductions in bacteria and B. coli were not as satisfactory as at lower river stages when the sprinkling filters were in service, and when low velocities allowed for the natural death rate and biological destruction of the bacteria.

This fact that bacterial pollution was carried downstream during periods of high water, when the oxygen balance was most satisfactory, convinced the trustees of the Sanitary District of Decatur that effluent pumps should be installed so that the sprinkling filters could be operated during high water.

A condition not shown by the surveys resulted from short but heavy summer showers during periods of low water, which caused the sewers to flow over the storm-water by-passes into the river. The flow in the river was low (3 to 10 mgd) and contained only about 6 ppm of dissolved oxygen. The stream was full of fish, many of which were killed or at least stunned between the water works dam and the sewage treatment plant. This occurrence prompted the construction of a storm-water treatment tank in 1932 to permit the sedimentation of more than four times the dry weather flow. Many small summer showers are now handled at the plant without overflow to the river.

BIOLOGICAL STUDIES MADE

The biological survey of 1918 and 1919, already mentioned, showed that for 30 miles downstream fish life could not exist except at high water and that the flora and fauna of the river bottom were composed almost entirely of pollutional organisms typical of septic organic matter. In the fall of 1926 a record flood occurred which cleaned out the accumulated sludge in the river. During the wet year of 1927 the river was in flood stage most of the time. This greatly aided in cleaning up the channel and restoring fish life to the river. During July and August 1928, after the new pre-aeration plant was placed in service and the entire flow of dry-weather sewage was being treated, rather complete biological surveys were made of the river from above Decatur Lake to the Springfield water works. These surveys showed that the microscopic flora and fauna of the river bottom were normal and characteristic of a normal stream. Furthermore, the samples from the bottom showed that the same kinds of organisms were present in Decatur Lake as in the river below Decatur.

Between the sewage treatment plant and the new channel, fish of nine varieties were caught in a seine and subjected to a careful examination. They were found to be normal, healthy, and free from parasites, and the contents of their stomachs and intestines were characteristic of their species. In 1929 the State Natural History Survey made a fish count (unpublished) and found many more varieties and about seven times as many fish a hundred yards below the point of discharge from the sewage plant as anywhere else in the river.

SUMMARY AND CONCLUSIONS

Surveys made by me and by others testify to the serious pollution of the Sangamon River between 1914 and 1928 for a distance of 15 to 30 miles below Decatur. In 1928 complete treatment of the dry-weather flow of sewage and trade waste and reduction in the concentration of the trade wastes by about 80 per cent allowed the production of a stable effluent from the sewage treatment plant. Since that time surveys of the river have shown it to be in excellent condition at low and medium stages. At stages of high water the oxygen balance of the stream has been satisfactory, but high velocities have carried bacterial pollution further downstream than is desirable. Further, until 1930 the sprinkling filters at the sewage plant had to be by-passed during high water, thus greatly increasing the bacterial pollution. The effluent pumps installed in that year to allow year-round operation of the sprinkling filters, were not operated until the spring of 1933, owing to the two-year drought. During the spring of 1933 a practically stable sprinkling-filter effluent containing nitrates and having a low bio-chemical oxygen demand was pumped into the river during high water.

Under present conditions the stream between Decatur and Springfield is most satisfactory for fish life from the viewpoints of oxygen balance and proper food.

The Trustees of the Decatur Sanitary District have been mindful of the condition of the Sangamon River and have taken numerous progressive steps to treat the waste of Decatur so that the river may support fish life and be in the best possible condition by the time it reaches the water works at Springfield, Ill.

Internationalization of Scientific Knowledge

Pooling of Resources as a Factor in World Economic Recovery

By A. P. M. Fleming

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Students of international industrial relations have shown considerable concern over the outcome of present unfavorable economic conditions. As Dr. Fleming here points out, mutual dependence is indispensable between countries as between the component parts of a single nation. Only the communal system of Russia, if it proves successful, will be immune from the ills of international competition. It behooves the other countries, he believes, to cooperate freely, especially in scientific pursuits, to their joint advantage. This address was delivered at the Chicago Convention on June 30, 1933, before a joint meeting of this Society, the Econometric Society, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials.

To direct attention to the economic possibilities of internationally concentrating and disseminating scientific knowledge and experience is important since it bears very strongly on two problems of world-wide significance: the social-economic problem of unemployment, which is world-wide in all countries except the Union of Soviet Socialist Republics; and the imminence of the challenge of industry as planned under the communal system of the Soviet Union to that planned on the individualistic and competitive system of other countries. The pooling on an international scale of scientific resources that can be applied to industrial development has a definite relationship to these two apparently divergent problems.

This relationship has three phases. In the first place, such pooling would further the evolution of international industrial relations. The fact that the distribution of natural resources bears no relation to political boundaries is a fundamental reason for international cooperation in their effective use by the community. In the early stages of industry, manufactures were of a local character, supplying local markets; later they became more national in character; and today, to a considerable extent, the industrial groups of different countries are interlinked.

Inventions and discoveries in one country quickly take on an international character and become the basis of manufacturing activity in other countries. This development of similar types of production in different countries demands a universal supply of raw materials, which have not been distributed by Nature according to political boundaries. Similarly, the experience and knowledge of men of genius, of inventors, of engineers and industrialists, may find an outlet in a country other than that to which these men belong. Hence in these days industry and commerce require for their economic development international interchange in many directions. It is remarkable that in a world which possesses all the natural resources and productive facilities to satisfy the needs of men, restrictions are set up which hamper the international working of the law of supply and demand. For instance, there are tariff restrictions between countries, restrictions relating to exchange, and restraints on the flow of currency. Then there are less tangible but equally far-reaching restrictions due to national aspirations. There is considerable danger, in fact, that the community will starve in a world of plenty.

While some international cross-connections have been established, as for instance to facilitate postal, telegraphic, and telephonic communication, to standardize regulations governing travel, and to some extent to regulate working conditions and hours of labor, these measures have not been adopted to promote industry but have followed as a consequence of its development. It is significant that under the threat of military aggression, to establish means for the destruction of material assets, nations deliberately cooperated—an impulse which is singularly lacking when cooperative effort to re-establish world economic prosperity is needed.

The second reason for the pooling of scientific resources on an international scale concerns the relation of science and industry to employment. The function of industry is to convert natural resources into a form suitable for the use of the community. In these modern days this conversion has given rise to a huge network of activity, in which every stage of every industry has become interwoven. This network should afford scope for the employment of the mental and physical energies of the greater part of the people in industrial countries, that is to say, in those countries where today unemployment is most severe. As the manufacturing industries have grown from local to national, and from national to international proportions, the problem of unemployment has developed correspondingly.

With increasing competition between manufacturers in the same industry and in different industries, both in national and international markets, the importance of improved methods of manufacture has been emphasized, and scientific knowledge has been increasingly employed to effect improvements resulting in the saving of time, effort, and materials. In the final analysis, these improvements in manufacturing efficiency are only secured by eliminating labor, that is to say, by increasing unemployment.

Improvement in efficiency gives an individual manufacturer an advantage over his competitors and enables him to secure thereby a greater part of the market, but the net result is to increase unemployment in his particular country. If a group of manufacturers by improved methods secure a greater share of the international market, then employment in one country is increased but internationally employment is decreased.

The great efforts that have been made—organized in some countries on national lines—to apply scientific knowledge by means of industrial research to effect industrial economies have for the most part increased unemployment rather than diminished it. It must be recognized, however, that as a national safeguard such efforts are of the utmost importance. Also, as a phase of world economic progress they conserve the economic resources of the world as a whole.

It may be argued rightly that if improvements in

manufacture result in a much cheaper product, the result will be an increase in demand, which will balance the loss of employment that would otherwise occur. This argument is only partially true and falls down badly when times are not prosperous.

Another aspect of this problem of applied science in relation to unemployment was recently emphasized in the report of a British commission which stated:

> This country [Great Britain] is finding its long-established preeminence in certain basic industries seriously challenged by the sedulous fostering of such industries by other nations in an endeavor to be more self-contained. In regard to other industries, the world is turning to rival products and leaving productive capacity in these industries, both here and abroad, much in excess of probable requirements. It is no use hoping or trying to reverse these tendencies. We must face the fact that much of the decline in some of our most important industries will be permanent, and we must turn our attention therefore more and more to the development of other existing or new industries which demand a higher degree of skill and scientific equipment.

An important point to note is the development of "new" industries as an alleviation of depressed industrial conditions. In seeking a solution to this unemployment problem, it is right to start with the manufacturing industries, because every worker directly employed in manufacture leads to the indirect employment of many others. In considering, therefore, the establishment of new lines of industrial activity to alleviate unemployment, attention should be directed first to manufacturable products.

The birth of an idea is the starting point of a new line of industrial activity. Ideas may spring from a variety of sources, but increasingly they come from scientific and technical workers. It is the conversion of the abstract idea to a concrete entity which enables the establishment of commercial enterprise and subsequent employment. For example, the ideas that emanated from Faraday, Henry, and others, a century ago, brought about the great electrical industry which today employs many hundreds of thousands of workers. Similar examples may be quoted in the chemical, metallurgical, and other industries. Bridging of the gap between the abstract idea and the concrete object proceeds in principle through certain definite stages; first, testing the truth of the idea experimentally; next, research to determine the possibilities of industrial application; then trial on a sufficiently large scale to test its commercial and economic possibilities; and finally, financing for the establishment of the productive facilities.

Today throughout the world there are large numbers of scientific and technical workers employed for the most part in the improvement of methods of industrial production, but to a much less degree is there purposeful and organized activity of such workers in the development of entirely new lines of industrial effort. The great reservoir of experience and knowledge which is being continually augmented is the potential source of new lines of manufacture which could be developed to alleviate unemployment. Individual firms are using their resources to this end, but as yet the possibilities on a national and international scale have not been recognized.

SOVIET UNION AN IMPORTANT FACTOR

The third phase of the international pooling of scientific resources concerns the relationship of the Union of Socialist Soviet Republics to other countries. The Soviet Union comprises one-sixth of the earth's land surface and has a population of nearly 150 million people of 200 different nationalities. Within its border are contained most of the natural resources required by man, and its government aims to develop these for the benefit of its own people with a view to making the standard of living as high as, if not higher than, that of other countries. Here are a great number of nationalities already internationalized in the most complete way with the absence of tariff barriers and international currency restrictions, and without any diversity of internal political aspirations. Its plan has been to divide manufactures into certain definite branches such as those relating to the heavy industries, the light industries, power production, and resources of raw material. Each of these groups constitutes a trust in which the productive units are under one control and have common research and educational organizations. Research, including that of a fundamental character, comes under one department of the state, so that all scientific work can be coordinated. A great expenditure has been made in setting up the most up-to-date laboratories and in selecting and training research workers. While these research activities are to a large extent imitative, considerable progress has already been made, and there is in Soviet Russia a larger body of organized research workers under unified control than exists in any other individual country in the world. The Soviet Government looks to science to play a most important part in its industrial and economic activities.

Whether its plans succeed or fail, already enough has been accomplished to show the possibilities of this combined scientific effort. Even partial success may have far-reaching effects on the rest of the industrial world. Should the standard of living be raised to the same, or to higher, levels than those of other countries, and should hours of labor be shortened as may in time reasonably happen, there would be a considerable degree of labor unrest in other countries. Moreover, the possibility must not be overlooked that Russia may become a great exporter of manufactured goods. This situation is developing at a time when there is little industrial cooperation among other countries. There is no doubt that this challenge of a communal plan to a competitive one justifies the careful consideration, by the other nations of the world, of the advantages of further cooperation, especially as regards the pooling of scientific resources and experience. With the lead that foreign manufacturing countries jointly possess and with the fullest use of their joint scientific resources, it should be possible to meet this challenge successfully.

POOLING OF RESOURCES IS JUSTIFIED

The internationalization of new scientific knowledge is already well established since it is the custom for workers in pure science to make known their discoveries as soon as they have succeeded in verifying them. In the case of science applied directly to industrial objectives, disclosure of the technical results is restrained for obvious commercial reasons, and protection either by patent or secret process is sought in order to reap a financial reward for the expenditure involved.

Protection of this kind is not so effective today as heretofore, since the facilities provided by modern scientific and technical resources are such that an objective once attained, if sufficiently coveted, can be attacked from so many angles that patents are likely to be circumvented and secret processes revealed. Taking this into consideration, recognizing the increasing need for all kinds of international cooperation, having regard to the challenge of the Soviet Union, and above all viewing the importance of the social-economic problem of unemployment, there appears to be every justification for a consideration of the pooling of scientific resources and experience for the ultimate economic welfare of all countries.

The Value of Planned City Development

A Record of 24 Years of Progress Under the Chicago Plan

By HUGH E. YOUNG
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, CHICAGO PLAN COMMISSION

IN 1909 the Burnham Plan for the development of Chicago was presented to the city, and the Chicago Plan Commission was created to put it into effect. In accepting the plan on behalf of the city, Fred A. Busse, then mayor, described the plan as follows: "The Chicago Plan is not presented as a scheme for spending untold millions of dollars now or in the future; on the contrary, it is a comprehensive suggestion of what may be accomplished in the course of years—it may be fifty, it may be a hundred—by spending, in conformity with a well-defined plan, the money which we must spend anyhow from time to time on permanent public improvements." The major accomplishments of the Chicago Plan Commission in the 24 years of its existence were outlined by Mr. Young in a paper read before the City Planning Division of the Society at its meeting on June 30, 1933, during the Sixty-Third Annual Convention in Chicago. The article here printed has been abstracted from his original paper.

WIDESPREAD appreciation of the value of far-sighted planning is indicated by the existence of nearly eight hundred official planning commissions in the cities of the United States. It is generally admitted that the present-day city planning movement in America is directly traceable to the influence of the Columbian Exposition, held in Chicago in 1893. Of all the city plans which resulted from the inspiration of that great fair, the Plan of Chicago naturally constitutes the most direct result, because the same persons were back of both movements. This discussion of the value of planned city development will be confined to the experience of the Chicago Plan Commission and the results which have followed the execution of some 80 or 85 major improvement projects.

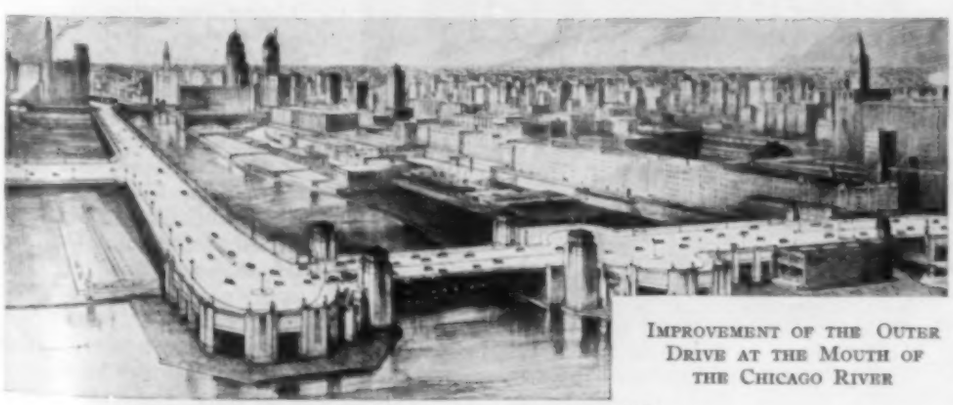
The Plan of Chicago was prepared under the direction of the Commercial Club of Chicago during the years 1906, 1907, and 1908, its author being the late Daniel Hudson Burnham; hence it is often referred to as the "Burnham Plan." The plan does not, however, represent the work of any one individual, but rather the combined efforts of the best city planning talent in the country and the concentrated judgment of the business leaders in Chicago—practical men who, in looking toward making it a more attractive city, never lost sight of its possibilities for further development along commercial and industrial lines.

In June 1909, the Plan of Chicago was published in the form of a handsome volume, profusely illustrated, which outlined the program in complete detail. An edition of 1,650 copies was distributed all over the world, thus supplementing the stimulus of the fair of 16 years before. The Commercial Club presented the Plan of Chicago as a gift to the city. After accepting the plan, the City Council established the Chicago Plan Commission, which was charged with the twofold duty of making the Plan of Chicago known to the people of the community, and of recommending to the City Council such public improvements suggested in the plan as in the judgment of the commission should be put into effect.

Today, as a result of 23 years of effort on the part of the Chicago Plan Commission, more than 80 of the major public improvements recommended in the Plan of Chicago have been actually accomplished and are serving the needs of the inhabitants of the city and producing the many benefits that were prophesied. Every improvement that the Chicago Plan Commission has recommended and the community has executed has been humanitarian as well as commercial in purpose.

With the aid of the slogan, "Reclaim every foot of the lake front for public use," which best describes its ultimate aims, the Chicago Plan Commission has devoted its greatest efforts to the reclamation, appropriate development, and beautification of the entire lake frontage. As a result, the people of Chicago today own and enjoy the greater part of the city's shore line. Jurisdiction over it is vested in the Lincoln Park and the South Park Commission.

Lincoln Park, on the north side of the city, consisted originally of about 300 acres extending along the lake for a mile and a half. In accordance with plans prepared for the park commissioners by the Chicago Plan Commission, this original area has been increased until today the park comprises upward of a thousand acres stretching for four and a half miles along the edge of Lake Michigan. When the proposed further extension is finished, Lincoln Park will border the lake for a total of six miles and will cover 1,852 acres.



IMPROVEMENT OF THE OUTER DRIVE AT THE MOUTH OF THE CHICAGO RIVER

Grant Park, in the center of the city, has an area of 303 acres. Jackson Park, on the South Side lake shore, consists of 543 acres of park lands. Between the two, a new park is being developed, named Burnham Park in honor of Daniel Hudson Burnham. This forms the site of the 1933

Century of Progress Exposition. Its 1,200 acres will make Grant, Burnham, and Jackson parks in effect one continuous lake-front park, extending for nearly eight miles along the edge of Lake Michigan and comprising a total area of 2,046 acres.

To complete the whole, a ten-million-dollar boulevard, known as the Outer Drive, is under construction at the mouth of the Chicago River to connect Field Boulevard in Grant Park with Lake Shore Drive in Lincoln Park. When this connecting link has been finished, Chicago will have a drive worthy of comparison with the famous boulevards of the world, stretching along the entire eastern boundary of the city and following the shore of Lake Michigan through what will be practically one continuous lake-front park 25 miles long.

In order to stimulate public use of the parks, recreational facilities have been generously provided. These include extensive bathing beaches, playgrounds, picnic grounds, flower gardens, bird sanctuaries, boulevards, athletic fields, field houses, yacht and boat harbors, and ski jumps. There are also facilities for golf, football, baseball, basketball, handball, tennis, quoits, and the like.

IMPROVEMENTS FOR COMMERCIAL PURPOSES

Similar health-promoting outdoor facilities are provided in the 32,000-acre system of forest preserves, which constitutes the other main humanitarian item in the Plan of Chicago. These wooded lands, which encircle Chicago in a series of tracts on the outskirts of the city, are eventually to be connected by a Forest Way 600 ft wide and 75 miles long. Under a reforestation program, a million trees have been planted each year for several years past. During 1932 the forest preserves surrounding the city were enjoyed by twelve million persons, three times the total population of Chicago.

There are other features of the Plan of Chicago which may be classified primarily as commercial. These include the carrying out of 49 separate street improvements, comprising the widening, opening, or extension of upward of a hundred miles of thoroughfares throughout the city, and fall into six main groups, as follows: the Quadrangle; connections between the Loop and the North, West, and South sides; the major street system; through streets; superhighways; and exterior highways, or good roads. The value of such improvements is to be found in traffic relief, increased property values, and new and better building development along the improved streets.

The Quadrangle is a downtown by-pass route designed to permit through vehicular traffic to avoid the crowded Loop streets. It is made up of Michigan Avenue on the east, Canal Street on the west, Wacker Drive on the north, and Roosevelt Road on the south. All four of these streets have been widened from 66 and 80 ft to 140, 100, 135, and 108 ft, respectively. Wacker Drive was named in honor of the late Charles H. Wacker to commemorate his 17 years of service as the first chairman of the Chicago Plan Commission.

Michigan Avenue is a conspicuous example of the value of a planned street improvement. Benefits similar to those derived from its improvement have resulted in varying degrees over the whole one hundred miles of street improvements that the city has carried out in line with the recommendations of the Chicago Plan Commission. This double-deck thoroughfare, which forms the eastern boundary of the by-pass quadrangle for downtown street traffic, was widened at a total cost of approximately $16,000,000. Of this amount about one-half was paid by special assessments levied against benefited property and the remainder was raised by the public through bond issues to cover the benefit which the public in general derived from the improvement.

Shortly after the improvement was completed, a study of its effect on surrounding property values showed that the value of property on Michigan Avenue and on parallel and intersecting streets had increased more than a hundred million dollars, and that as a result of the improvement another hundred-million-dollars' worth of new buildings had been erected on the avenue itself and in the neighborhood.

A second benefit derived from the widening of Michigan Avenue was the breaking of the barrier between the Loop and the North Side, and the consequent enlargement and extension of the central business district into the area north of the river. A third benefit was the facilitation of traffic movement, which after all was the main reason for the widening of this thoroughfare. Before its construction 9,725 vehicles per day, by actual count, crossed the Chicago River by way of the Rush Street Bridge, now replaced by the new Michigan Avenue double-deck bascule structure. The latest traffic counts show that more than 85,000 vehicles per day are crossing the river at this point. Therefore this street betterment improved traffic facilities by 775 per cent, not to mention the advantages of separating the conflicting streams of traffic, which were secured by the two-level construction.

IMPROVEMENT OF TWO-LEVEL WACKER DRIVE
Built Along South Bank of the Chicago River Between Michigan Avenue and the Intersection of Market and Lake Streets. Its Extension East of Michigan Avenue Will Connect with the Outer Drive Boulevard Now Under Construction

ADDITIONAL STREET CONNECTIONS SECURED

The second group of street improvements in the Plan of Chicago includes additional street connections between the heart of the city, commonly known as the Loop, and the North, West, and South sides. The purpose of these connections is to unify the city and to break up the sectionalism produced by such barriers as the Chicago River and its branches and the railroad yards, particularly those to the south, which, except for a single north-and-south street,

cut off the South Side of the city from the Loop. Considerable progress has been made in providing the new connections recommended by the plan. Examples of such connections are the Wabash Avenue Bridge, the La Salle Street and Monroe Street bridges, and the Franklin-Orleans Street Bridge. Still another is the partially complete Outer Drive Bridge east of Michigan Avenue.

The third group of street improvements in the Plan of Chicago is known as the major street system. This includes the eventual widening of every section-line thoroughfare in the city, and possibly even of the quarter-section-line streets, from end to end. A number of these major streets have already been widened. For instance, Western Avenue has had its width increased from 66 to 100 ft for its entire 26-mile length in Chicago, and Ashland Avenue has likewise been widened to 100 ft for nearly the same distance.

A system of rapid-traffic thoroughfares, known as through streets, before entering which all cross traffic must stop, comprises the fourth group of street improvements. In brief, this group consists of forty or fifty traffic routes criss-crossing Chicago and providing continuous, protected, and efficient arteries for rapid-traffic movement. The major part of this through-street system is now completed.

The fifth group of street improvements has been designated the superhighway system. This consists of a plan for a complete system of elevated highways to be built above the normal street system, beginning at the city limits to the north, west, and south and at the 12 or 13 main highway routes to and from Chicago, and so laid out as to permit an uninterrupted flow of traffic through the city. This system of grade-separation streets will enable through traffic to continue its journey into and through the city without interruption or delay, and without using any of the normal-level streets. These superhighways will have no cross traffic, no turning traffic, and no need for stop-and-go signals except perhaps at points where one elevated superhighway intersects another at grade.

The sixth and final classification of thoroughfare improvements recommended in the Plan of Chicago concerns the provision of a complete system of good roads or exterior highways, some radiating out from the city and others surrounding it in three concentric belts. Snice 1925 the highways throughout the Chicago region have been developed in accordance with the recommendations of the plan. As a result, the city is today the focal point of one of the finest highway systems in the country.

Chicago Aerial Survey Company

CHICAGO RIVER CHANNEL STRAIGHTENED
The Bend Is Now Filled In

RAILROADS COOPERATE IN THE PLAN

Railway transportation is of equal if not greater importance to Chicago than street and highway transportation, because the city is primarily an industrial, manufacturing, and commercial center. There are more miles of railroad track within the city limits than there are in many states and in the whole of certain foreign countries. Although the principal railway systems of the United States have their terminals in Chicago, no railroad goes through the city. It is the one inland city in the whole country where every passenger must get off a train of one railroad and transfer to that of another in order to make a complete journey from an outside starting point to an outside destination. Therefore adequate railway terminal facilities are a matter of major importance.

Negotiations in which the Chicago Plan Commission participated as adviser to the City Council resulted in an agreement between the railroads and the city. In this agreement not only were the city's interests safeguarded, but improvements to the value of $6,000,000 were obtained from the railroads, plus a cash payment of $1,500,000. According to the articles of this agreement, the railroads abandoned their original freight-yard plans in order to avoid interference with the street system of the Plan of Chicago. In addition they cooperated in straightening the South Branch of the Chicago River between Polk and 18th streets. They also widened viaducts over the station tracks and made the viaduct roadways level with the river bridges; and they made provision for many other improvements.

Likewise the Chicago Plan Commission was instrumental in obtaining equally important concessions for the public from the Illinois Central Railroad in connection with its proposed new lake-front terminal. The Illinois Central Railroad transferred its riparian rights on the shore of Lake Michigan to the South Park Commissioners, so that the lake-front improvement could be carried out. In addition to making numerous other improvements, it electrified its facilities and depressed certain tracks. It also agreed to have its passenger terminal, which will front on Roosevelt Road, conform architecturally with the nearby Field Museum of Natural History.

The Plan of Chicago contains complete plans for harbor development, and the Plan Commission has consistently and insistently urged the proper development of the city's waterway facilities, including the Lakes-to-Gulf Waterway through the Mississippi Valley, connecting Lake Michigan with the Gulf of Mexico, and the proposed St. Lawrence seaway connecting the Great Lakes with the North Atlantic Ocean.

The final type of transportation in which the Chicago Plan Commission has interested itself is aviation. The city's municipal airport was advocated, and its location selected, by the Plan Commission.

A BETTER CHICAGO EMERGING

Those connected with the commission think that the improvements carried out in accordance with its city plan have abundantly demonstrated their value. Sometimes it is a social consideration that is uppermost, sometimes an economic. We believe that because of these improvements Chicago is a better city in which to live, that it knows more clearly where it is going, dares to be hopeful in the midst of a world-wide economic depression, and expects, when times are more favorable, to carry the Plan of Chicago further toward ultimate fulfillment.

Preparedness for Slum Clearance

A Problem Confronting the Cities in Which Federal Aid Can Help

By JOHN H. MILLAR

EDITOR AND PUBLISHER, MILLAR'S HOUSING LETTER, CHICAGO, ILL.

SLUM clearance and the elimination of poverty go hand in hand. Low-cost housing projects erected in the blighted areas of cities offer one solution, but many obstacles stand in the way. Not the least of these is public apathy. Others mentioned by Mr. Millar are lack of the legal machinery necessary to proceed with any large-scale slum elimination project and inflated property values in the blighted areas. He finds hope of financing such projects through the Public Works Administration of the National Industrial Recovery Act and makes a plea for the immediate development of adequate master plans in cities where slum clearance is a problem so that advantage may be taken of the opportunity presented. This article has been abstracted from the paper presented before the City Planning Division of the Society on June 30, 1933, during the Sixty-Third Annual Convention in Chicago.

ALTHOUGH large sums of Federal money are available for slum clearance, engineers are ill prepared to tackle the job. It is a much larger undertaking than is generally realized. The basic reason for the existence of slums is poverty. Slum clearance, therefore, is as fundamental and involved a matter as the elimination of poverty itself. It represents a problem men have been seeking to solve for thousands of years, and it is still with us.

In a narrow sense, slum clearance means the demolition of dilapidated and unsanitary dwellings in cities and their replacement by better homes for the poor. In a larger sense it means the planning of entire urban regions so that people may live in those sections where they can get the most in comfort, happiness, and means of livelihood for such sums as they have to spend. This requires the development of subsistence farming units for part-time workers on the outskirts of cities. It demands the allocation of larger areas, within present city limits, to parks and other public uses. In a still larger sense, slum clearance means comprehensive social planning. It involves the finding of ways and means by which surplus time can be devoted to productive uses. This end may be served by the development of new industries, by further refinements in social service work, by the fostering of arts and crafts, or by all these means and others.

Slum clearance is, therefore, a long-range problem. But what steps should be taken at the start? There are obstacles to be overcome before any steps can be taken, and these obstacles must be analyzed before they can be removed.

The first of the obstacles to slum clearance is the lack of an awakened and active public opinion. This is now developing, and in such matters public opinion can gather momentum rapidly. As long as slum clearance is looked upon merely as a means of creating jobs for architects who want to build modernistic apartments, public opinion will not be a force in its promotion. But when citizens come to realize that a proper program of slum clearance is an attack on poverty and unwholesome living, not merely on one front but on many fronts at the same time, then public opinion in favor of it will be developed.

One of the obstacles born of public lethargy is the absence of adequate facts upon which to base programs of action. There are only a few scientific fact-finders working in this field. Because of the tremendous economic and social changes that have taken place in the short period since the last Federal census, it is especially imperative that fact-finding be kept up to date.

SEVENTEEN PEOPLE CROWDED INTO AN UNSANITARY CHICAGO TENEMENT
One Reason for a Slum Clearance Program

Since public opinion on the subject of slum clearance has not been aroused and the essential facts concerning it are unknown, it is only natural to find that adequate plans for it do not exist. The absence of these plans is a special handicap now. It has been stated by Harold L. Ickes, Secretary of the Interior and head of the board of Cabinet members which is directing the public works program, that priority will be given public works which are part of a comprehensive plan for community, municipal, or regional development. Such plans are woefully lacking. In too many instances city planners have been too busy widening streets, rounding curbs, locating monuments, designing unproductive civic centers, and arguing fine points of applied zoning, to attack the larger and more fundamental problems of rebuilding American cities. More high-powered thinking in city planning is needed. The layman looks to the engineer for much of this thinking.

Besides these barriers to progress in slum clearance, there is the obstacle of inadequate legal machinery. Here and there

state housing laws have been enacted to authorize a certain type of limited-dividend housing corporation, but the success of such corporations has to date been limited. Such housing laws usually carry the power of condemnation, subject to numerous restrictions.

Most other countries have laws permitting their governing bodies to deal with slums as areas, and not parcel by parcel. Under such legislation a whole district may be set aside for replanning and rebuilding. Holders of land in the area may be given other land of equal value, or they may receive payment in cash. As yet, however, there is no such legislation in this country and little public opinion that would further its enactment. When slum clearance actually gets under way and more adequate legal machinery is found necessary, it is possible that such legislation will be enacted quickly. Such things can be attended to very promptly when a great work-creating program is involved.

Another obstacle to slum clearance, and one that is looked upon by many as the most important, is our false system of valuing land, which is so well established that its falseness is now somewhat obscured. Until very recently, this was a pioneer nation, always with some frontier that could be developed. Land speculation flourishes in frontier countries, and America has had its full share. The value of land has been looked upon, not as something to be determined by the probable returns from the use of the property, but as something to be determined by what might be paid for it by someone else, who thought he might resell it at a profit, and so on. In short, our whole system of land valuation is unsound.

BASE LAND VALUE ON RETURN FROM HIGHEST USE

To get rid of this system of valuing land and replace it by one in which land is evaluated according to the returns from the best use of it, will be exceedingly difficult. It will involve much injustice and the taking of large losses by many honest people. With property rights jealously guarded by our constitutions, both state and Federal, and with juries and courts made up of men who highly respect the traditional system of land valuation, it will be a great struggle to secure land in blighted areas for low-cost housing projects and poor men's parks at prices that can be afforded.

TWO "APARTMENTS" AND A "COTTAGE" IN CHICAGO SLUMS
Occupants Are Not Working and Have Not Paid Rent for Months. There Are No Sanitary Facilities, No Grass, No Flowers

The main hope at present is that the Federal Government may aid somewhat in working out a solution. However, even this will be difficult, as resistance to the deflation of land values will be very powerful. It may be so powerful that many slums will be allowed to fall into decay while slum dwellers move out to the edge of town where they can live more normally and satisfactorily. This is about the only kind of slum clearance available at present, and to a large extent it only dodges the issue. The excessive valuation of land is the reason why this issue must be dodged.

Financial obstacles to slum clearance, heretofore of supreme importance, have now been largely removed if the new law creating the Public Works Administration turns out, in actual operation, to mean what it says. Money will be available at $3\frac{1}{2}$ or 4 per cent and loans will be amortized over a long period of years, possibly at rates as low as 1 or $1\frac{1}{2}$ per cent a year. Furthermore, it is provided that the Federal Government may make an outright grant of 30 per cent of the cost of labor and materials when slum clearance is undertaken by "states, municipalities, or other public bodies." The next question is to find out just what "other public bodies" are. Some think that slum clearance authorities on the order of the Tennessee Valley Authority can be created. The latter President Roosevelt described as a public body having the flexibility and other advantages of a private corporation.

NINE FAMILIES CROWDED INTO THIS SOUTH DEARBORN STREET "APARTMENT HOUSE"
None of Them Are Able to Pay Rent

PREPARATION OF MASTER PLANS

The tendency today is definitely toward more social control. The uncontrolled use of land and the uncontrolled erection of buildings have been so damaging to persons and to property values that it is only logical to expect a marked tendency toward the social control of land and the buildings on it. Who knows but that the metropolitan planning bodies now being set up may evolve some day into regional governments which will take over many of the duties of existing smaller governments and possibly supersede many of them entirely? Certainly the initiation of a metropolitan public works administration would put an end to many small parks boards, drainage districts, sanitary authorities, and the like, such as abound in a number of places.

This greater public control can be so exercised as to result in more real freedom for the average person in his daily living. Such public control would not be directed toward the private life of the individual but rather toward the predatory and semi-predatory business operations that have added so greatly to his cost of living and so restricted his surroundings that no real freedom for him has been possible.

Under the system now being developed, attention will be concentrated upon building in neighborhood units, which will contain not merely a group of dwellings but all the necessary commercial structures, schools, churches, civic centers, and parks. This system will contribute greatly to the development of the right kind of community life in each neighborhood. The managers of the large corporations which undertake such building programs will find it to their interest to promote the type of living that has been suggested. It will make their properties more stable in value.

Surveys of Government Lands

Retracing the Lines and Replacing the Monuments of the Early Land Surveyors

WITH certain modifications, the system for surveying and describing the public lands of the United States in use today is that developed by Thomas Jefferson in 1784—a remarkably comprehensive checkerboard system of square-mile sections. Until about 1910 the field work was done by surveyors working under contract at pitifully low prices per mile. Considering the handicaps under which the early surveyors worked—hostile Indians, forbidding country, unfavorable weather conditions, primitive means of transportation, and crude instruments—it is a wonder that they were able to monument their surveys at all. Inasmuch as the original monuments, no matter how inaccurately set, legally mark the section boundaries, it is important that they be relocated. The modern surveyor is often required to exercise extraordinary ingenuity in discovering or correctly resetting those he needs to subdivide the land within the sections. A high order of knowledge, training, and experience is required, as set forth in the two articles that follow, both abstracts of papers presented on June 30, 1933, before the Surveying and Mapping Division of the Society at its Sixty-Third Annual Convention in Chicago.

Land Surveying—Its Foundation and Superstructure

By M. L. GREELEY

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BEARING TREE IN NORTHERN WISCONSIN WOODS MARKED ABOUT 1850

IN the year 1784 a committee of the Continental Congress, of which Thomas Jefferson was chairman, was charged with the duty of developing a plan for laying out and describing the public lands, then an immense area, for sale to, and occupation by, settlers. The plan which they conceived was unique, simple, and definite and included, besides the monumenting and marking of corners, the collection of much information which aided the settler in his choice of land, such as the location of lakes, water courses, swamps, wooded land, prairies, hills, and mountains; quality and character of the soil; and presence of minerals. The wisdom and benefits derived from the system are difficult to appraise, but there is no doubt that it contributed very greatly to the peace and happiness of the owners of land which came under its jurisdiction.

The plan is rectangular in pattern and is based on meridians and parallels of latitude. The township, containing 36 sections, each a mile square, is the foundation of the system. Certain meridians, known as principal meridians, were selected, and from them the townships were numbered progressively east and west. From certain parallels, known as base lines, the townships were numbered progressively north and south. The sections within each township were numbered from one in the northeast corner to six in the northwest corner, and so back and forth across the township, ending with Section 36 in the southeast corner.

The description of any tract of land under this system is absolutely definite and does not require mention of the state or county in which it is located. For instance, the "Northeast quarter of Section 16, Township 39 North, Range 1 East of the 3d Principal Meridian" is located in the heart of the business district of Chicago, and is bounded by State Street, Madison Street, the Chicago River, and Harrison Street. No other quarter section in the United States can have this description. Any competent land surveyor can locate it positively with very little trouble by referring to the U.S. Government Survey maps. The definiteness of this simple description is a unique feature of the system.

PROVISION FOR ERRORS AND INACCURACIES

The committee headed by Thomas Jefferson did not realize the practical difficulties of applying to a sphere a rectangular plan calling for 36 square sections to a township. The convergence of the meridians toward the north pole caused a narrowing of the townships as they extended northward.

In the instructions of 1855 issued by the General Land Office to Surveyors General, the following paragraph appears:

> Standard parallels (usually called correction lines) are established at stated intervals to provide for, and counteract, the error that otherwise would result from the converging of meridians and also to arrest errors arising from inaccuracies in measurements on meridian lines, which however must ever studiously be avoided. On the north of the principal base line it is proposed to have these standards run at distances of every four townships, or every 24 miles, and on the south of the principal base line at distances of every five townships, or 30 miles.

So at least every 24 miles, the townships and section corners were laid out starting from the principal meridian. The township and sections to the south were laid out by courses and measurements beginning on the base line or a correction line at the south corner of Sections 35 and

36; thence north 40 chains for a quarter corner and 80 chains for a section corner; thence east 40 chains for a quarter corner and 80 chains to the township line previously run. If the surveyor did not close on the corner as set he was to correct his line to do so.

In this manner he continued the subdividing until he reached the correction line, where all the discrepancies were thrown in and differences noted. The differences were of considerable amounts, as much as one or two miles in a township. In this way the difficulty of applying the rectangular system to a sphere was met.

Whereas the system as designed is deserving of great praise, the results obtained by the surveyors were not so satisfactory as to merit unstinted approval. Yet the men who did the field work should not be censured too severely for the errors and omissions which are now found in their work, considering the difficulties under which they were obliged to labor.

ROUGH WORK IN A WILD COUNTRY

The great area which was included in the operation of the system was rough country, inhabited by wild men and wild animals. The surveying parties most of the time were many miles from any settlement from which they could obtain supplies or help in case of sickness or attack. They were subjected to adverse weather conditions, extreme heat and cold, rain and snow, high winds, drought, and insect pests. In addition they worked with crude instruments, such as the double-sight compass mounted on a Jacob staff, and the Gunter chain, two rods long. The tools were unreliable, and the men who did the work were not always the most competent. It is perhaps surprising that they did as well as they did.

Another element entering into this situation was the poor pay which the surveyors received—$4 to $12 per mile for subdividing the townships and $12 to $20 for running meridians and base lines. Out of this they paid all the expenses for men and equipment. The latter was a considerable item, consisting of instruments, chains, pins, axes, scribing tools, chisels, files, notebooks, table books, shovels, camp outfits, provisions, clothing, bedding, guns, fishing tackle, and much else. To transport all this baggage, several teams and wagons were required and probably saddle horses, items which must have cost a considerable amount.

The phrase "running a line" was literally true because they must have run in order to cover enough miles per day to make a living. The early surveyor can be imagined as grabbing his Jacob staff and jabbing it into the ground on the line to be run, setting the compass on it, pushing the staff as required to make the compass approximately level, setting the course, and lining a foresight as far ahead as his eyesight and his conscience would permit, the latter being the more elastic of the two. He then pulled up his staff and compass and ran on to his foresight to repeat the process. He rarely used a back sight by which to produce the line but relied entirely on the compass. If a tree came on the line, he moved up and set his compass beyond the tree, estimating the location of the line by eye. So the supposed straight line is a series of lines making angles and jogs at each setting of the compass.

The U.S. Government, having once established the corners of the townships and sections, never resurveyed them. The replacing and perpetuating of the corners was to be done by local surveyors. It was important therefore that the corners should be monumented as permanently as possible and referenced to blazed trees and any other fairly permanent object. To further perpetuate the corner, the instructions provided that pits of certain size and depth should be dug to the north, south, east, and west of it at equal distances, and not more than 6 ft from it. The earth from the pits was to be piled around the post, packed firmly down, and sodded where possible. When possible the surveyor was to plant seeds of trees, preferably those of fruit trees, midway between the pits and the corner, hoping that eventually a small clump of trees would mark the location of the corner.

ANOTHER BEARING TREE IN NORTHERN WISCONSIN MARKED ABOUT 1850 Found By H. C. Hall in 1925

The corner posts or stones were notched to indicate the position of the corner, a notch for each mile from the township line. If a post marked the corner, the end was to be charred, and if a stone was used a little charcoal or a charred piece of wood was to be placed against it under the ground. Other materials could be used, such as glass, stoneware, potsherds, marked stones, cast iron, charcoal, or other foreign matter, buried under ground. The location and description of these buried memorials were carefully noted in the surveyor's running notes.

Considering all the provisions that were made for perpetuating the corners, one would expect to find the charred end of a post, the witness tree, or evidence of pits, buried memorials, or fruit trees. But after the lapse of a hundred years or more, the surveyor today finds that all evidence of many of the corners has been obliterated. The wind and the herds of buffalo or other animals have destroyed the mounds and pits. The posts and witness trees have rotted away or been destroyed by forest fires, floods, tornadoes, or the acts of man.

RELOCATION OF LOST CORNERS REQUIRES SERVICES OF AN EXPERT

It is here that the land surveyor, a trained and skilled expert, is called upon to replace the lost corners. This work requires an expert, for the man unfamiliar with the methods employed by the Government surveyors and inexperienced in identifying witness trees, will fail to find evidences of the trees and will use erroneous methods in reestablishing the corners.

The General Land Office gives a few instructions for the restoring of lost or obliterated corners, among them being the following:

> After all rules and instructions that can be given for reestablishing obliterated public surveys, much will depend upon the skill, fidelity, and good judgment of the surveyor for the correct performance of the work. The most difficult point in laying down instructions and one on which something must be left to the good judgment of the surveyor is in regard to what shall be considered sufficient evidence in these cases. A definite rule can no more be prescribed in this respect concerning surveying, than a law could be enacted defining just how strong the testimony in a given case should be to satisfy a justice or a jury. The sound judgment of a competent surveyor in this matter will seldom lead him into error.

In this manner the General Land Office deftly passes the responsibility on to the surveyor with a pleasing sop to his vanity at the end.

By 1850 Burt's solar compass had been invented and was required to be used on Government surveys. This was a great improvement over the old magnetic compass on a Jacob's staff. The use of the Gunter chain was continued until some time in the eighties, when it was replaced by the steel tape. Since these improved instruments have been used, the surveys have been much more reliable.

The U.S. Government land surveys are the foundation for all property surveys in all the states except the 13 original ones and Kentucky, Tennessee, and Texas. The superstructure is the work done by the local surveyor in making subdivisions within the sections. Much of this work was done many years ago, when land was cheap and the surveyor poorly paid. He was still working on the land in the rough, and accurate measurement was difficult without the expenditure of too much time and money.

If called upon to survey the east half of the northeast quarter of a section, the early surveyor would take the west line of this east half at 1,320 ft west of, and parallel to, the east line of the section. He should have measured the north line of the section to obtain its actual length and taken the northwest corner at one quarter of this measurement. He then should have run the two quarter-section lines to an intersection for the center of the section, which the Government surveyors never established; measured the south line of the northeast quarter; and taken the southwest corner of the east half at half this distance. But to follow such a procedure would have taken much more time and added to the cost. Would the value of a few feet of land warrant the additional cost? He decided it would not and adopted the quickest method of completing his survey. But in some cases the value of the land later increased enormously and its owners fought over inches. The section probably measures 20 to 40 ft more than the theoretical mile, and so the owner may lose a strip 5 to 10 ft in width by 2,640 ft long. In later years, when land values had increased considerably, such a strip of land might cause trouble and possibly litigation.

Corners set in the subdivisions laid out in prairie or farm land disappear when improvements are put in. The construction of sewers, sidewalks, and fences, and the erection of buildings, all contribute to the removal of the corners. Frost lifts the stakes and the mower does the rest. The junk man reaps a harvest in pulling out the iron pipes.

Land surveying is a very old profession, which probably began when man ceased to be a nomad and acquired a settled habitat. The inscriptions and representations on the walls of tombs and buildings bear testimony to the work of surveyors in the early Egyptian dynasties. Later, in the days of the Roman Empire, they were a highly respected, well paid, and distinct professional class.

CANADA'S HIGH STANDARD FOR SURVEYORS

Canada appreciates the importance of the land surveyor's work and has adopted very stringent laws governing his examination and registration. Applicants for registration must pass satisfactory examinations in the following subjects: analytical geometry; astronomy; methods of surveying and calculation of areas; leveling; location and construction of roads; principles of irrigation and calculation of water power; plan mapping; projection of maps; drawing instruments and drafting; manual of instructions of surveying of Dominion lands and the Dominion Land Act; elementary geology and mineralogy; principles of evidence, taking of affidavits; and practical surveying and observation. This comprehensive examination practically limits the applicants to college graduates and creates a body of well educated and well trained men in the surveying profession whose training must be reflected in the quality of their work.

For purposes of comparison the following incident is of interest. About 1920 the question was brought before a court in Kentucky as to whether land surveying was a profession or a trade. The court gave as its decision that land surveying was a trade, and this was later confirmed by the supreme court of the state.

SURVEYOR AS COUNSEL, JUDGE, AND JURY

To the casual observer the lot of the surveyor seems a very happy one. He appears to be carefree and contented as he steps along the country road or city street, drawing his tape measure after him and stopping now and then to make some notation in his field book. Or, setting up his instrument and looking through it, he waves his hand to right or left and finally waves both hands at once. He then retires perhaps to the friendly protection of a tree or building, where he sits and writes and calculates.

It looks easy and delightful, but the surveyor alone realizes that such field work is only the beginning of his task. He must then arrange his facts and the testimony of such silent witnesses as fences, roads, buildings, stakes, and stones, and so arrive at the location of the lost corner. He is counsel, judge, and jury. As counsel he must present his case and bring in his witnesses, notations, and observations. As judge he must instruct the jury and pass on objections, and as jury he must render the verdict.

The Land Surveyor's Starting Point

By W. D. JONES
LAND SURVEYOR, CHICAGO

BY the Ordinance of 1785, which created the American land system, the initial point for the Government surveys was to be "on the river Ohio, at a point . . . due north from the western termination of a line which has been run for the south boundary of . . . Pennsylvania." It was later provided that the first principal meridian should run due north from the mouth of the Great Miami River; the second principal meridian, north from the confluence of the Little Blue River; the third principal meridian, north from the mouth of the Ohio River, and so on. Actually, all these points and lines were created by the monuments set by the land surveyors; and so also were the corners of the townships, sections, and quarter sections. The question that pre-

sents itself is : Have these monuments lasted until now?

In the case of Corbin vs. Baltimore and Ohio Chicago Terminal Railroad Company, in 1918, the Supreme Court of Illinois decided "that at all Government section corners permanent monuments exist." The court also said, "There was no necessity . . . to plant or fix any stone as a monument from which the measurements aforesaid could be made" since "every lot and lot line and corner and every alley or street line can be definitely located on the plat in question by surveys and measurements from any section corner."

In 1859 Abraham Lincoln said, "Nearly, perhaps quite, all the original surveys are to some extent erroneous, and in some of the sections, quite so." These two statements, one by the Illinois Supreme Court, the other by Abraham Lincoln, contradict each other. Lincoln's statement is correct. It is very evident that if the court had known the facts stated by Lincoln, it would not have said, "every lot . . . line . . . can be . . . located . . . by . . . measurements from any section corner." It is also very evident that any man who does not know the truth contained in Lincoln's statement is not competent to decide where the land surveyor gets his starting point.

A hundred years ago the original surveyor had only the chain, which was commonly too long, and the compass, with which he could not run a straight line. The land was so cheap, and he was paid so little, that in most cases he did not think he could afford the time to do his best with the tools he had. Therefore no section is a perfect square, nor does it have any perfect form. No two sections are the same. Rarely, if ever, do any two section lines or any two half-mile lines measure the same length.

HOW WERE THE ORIGINAL CORNERS SET?

In most cases the original monuments were posts or posts in mounds of earth, set about one hundred years ago. If any of these exist today it is because the township in which they stand has not been settled and improved. In most cases where the land has been improved, certain acts of the settlers, such as building a fence in line with the monument, have served to witness the true location of the corner. In many cases a new monument has been set by a land surveyor in place of the old one which was disintegrating. But in some cases new monuments have been set for the corners by incompetents, at places other than their true location. Sometimes, therefore, two monuments are found for the same corner. It is then quite necessary to recognize the truth of Lincoln's statement of 1859.

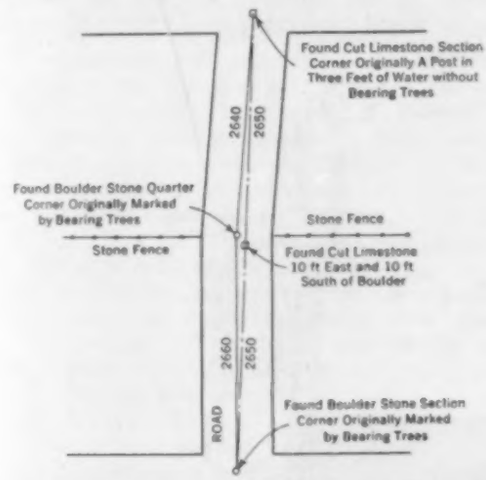


FIG. 1. REESTABLISHING A QUARTER SECTION CORNER
Which Location Is More Probably Correct for the Quarter Corner?

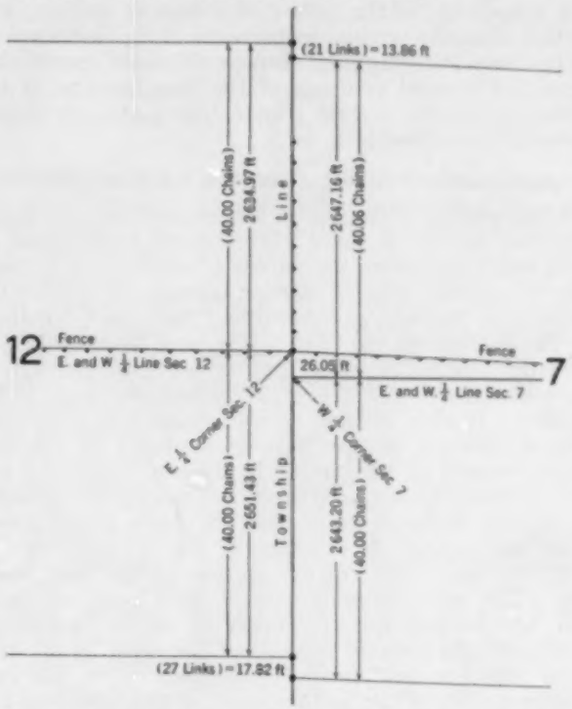


FIG. 2. QUARTER SECTION CORNERS ON A TOWNSHIP LINE
Is the Fence in Section 7 East Good Evidence of the Location of the East Quarter Corner of Section 12?

The surveyor must know how to read the acts of men who may have long since passed on. He must know, for example, that a boulder stone for a quarter corner which once had bearing trees, and which stone stands in the center of a north and south highway and on a line with old fences both to the east and to the west, is better evidence of the true location of a quarter section corner than a cut limestone marker 10 ft to the east and 10 ft to the south of it. The boulder stands 2,660 ft—that is, 20 ft more than the Government record distance—to the north of a boulder stone for the section corner to the south, where once there were bearing trees. It stands 2,640 ft, just Government record distance, to the south of a cut limestone marker for the section corner to the north, where there were never any bearing trees but originally only a post in 3 ft of water. This situation is shown in Fig. 1.

The cut limestone quarter corner is found to be halfway between, and on a straight line with, the stones for the two section corners. The surveyor must know that the true location of a quarter section corner is never as exact as this. If and when competent land surveyors so relocate a quarter section corner, they do so only because they have no better evidence of its true location. Also a quarter corner with bearing trees had a much better chance of being preserved than did a section corner that was only marked by a post in 3 ft of water. The modern surveyor knows also that the chains used in 1834 were nearly always too long. It is therefore reasonable to conclude that the cut limestone for the section corner to the north of the quarter corner was placed just 2,640 ft north of the boulder stone for the quarter corner by a recent correct measurement of the half mile. Evidently the cut limestone block is not the true location of the

original section corner, as marked by the post in 3 ft of water in 1834.

In order to understand where the land surveyor gets his starting point one must be able to see that if a half-acre school lot, in the corner of a quarter section, was deeded when the original monuments of the Government survey were still standing, then an old fence around this school lot is good evidence of the true location of the section or quarter section corner, which also marks one corner of the school lot.

FOLLOWING ORIGINAL SURVEYOR'S INSTRUCTIONS

When dealing with quarter section corners on a township line, having in mind Government instructions of 1815, which instructed the surveyor subdividing a township to use the quarter section corners created for the sections on the west as constituting the quarter corners for the sections on the east. The man who would find the true location of these quarter section corners must know whether or not the 1815 instructions apply in his locality. If they do not, he will realize that if he finds a fence running to the west as evidence of the east quarter corner of the section in the west township, and finds a fence running east from the same point straight for a mile, he must know that the fence running east is not and cannot be evidence of the quarter line, or west quarter corner, of the section in the east township. The fence running east is good evidence, however, of the east quarter corner of the section in the west township because some land surveyor must have given line for that fence, erroneously using the east quarter corner of the section west of the township line as being also the west quarter corner of the section to the east. In Fig. 2 this problem is illustrated and the incorrect location of the fence in the section east of the township line shown. In the absence of other evidence the west quarter corner of Section 7 is reestablished by proportional measure between the northwest and southwest corners of Section 7.

Suppose, for example, that a land surveyor is given an old metes and bound deed for a tract of land in the southwest corner of a quarter section, which calls for the original monument of the Government survey as a starting point. The deed says, "beginning at said monument at the southwest corner of said quarter section; thence South 88½ degrees East," and then gives other courses and distances which cannot be made to agree with known location of the quarter section lines and close. The land surveyor finds that on the Government survey plat the south line of the section is marked "North 88½ degrees East," and he then tries to make the deed description close by assuming that, in this deed, "South 88½ degrees East" should read "North 88½ degrees East." Neither does this assumption make the deed description close. Then he assumes that the south line of the quarter section is "South 88½ degrees East" and takes the other courses and distances given as if the true south line of the quarter section were "South 88½ degrees East," and finds that his lines agree with some very old fences around this tract of land and will close. However, the closing course forms a right angle with the south line of the quarter section. The land surveyor must then be able to see that the old fences are good evidence of the true location of the quarter section corner he is seeking. He must realize that the man who surveyed for the making of the old deed evidently had the true south line of the quarter section but did not have the west line, except at the south quarter corner of the section. This original surveyor was too careless to rerun the west line and simply turned at right angles to the south line, thereby staking out and deeding part of the property in the quarter section to the west, which did not belong to his client. The successive steps taken to relocate this plot are shown in Fig. 3.

There is not space here to treat of the refined exactness used in determining the land surveyor's starting point in surveys of valuable city property, but the fundamentals of such surveys are about the same as those in the cases just mentioned. When the land surveyor knows exactly where to get his starting point, his job is just about finished. But the surveyor can only determine this point after he has carefully weighed all the evidence that can be found concerning the location of the original monuments.

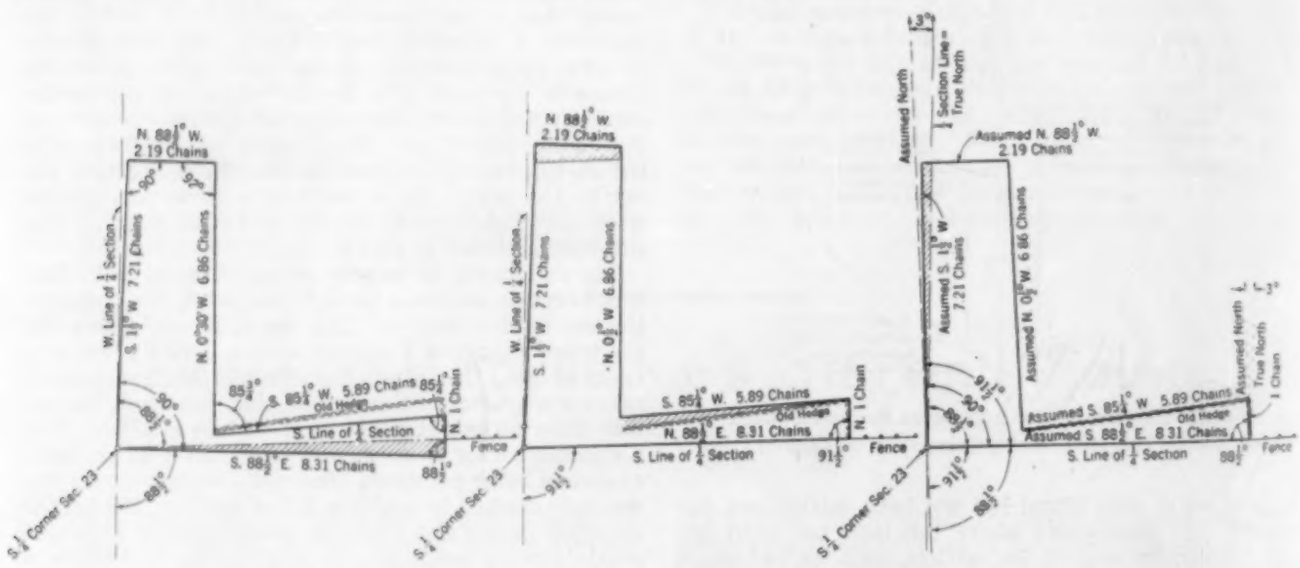


FIG. 3. FENCES AND HEDGES AID IN RETRACING AN OLD AND INACCURATE SURVEY

The Description in the Old Deed Reads as Follows: "Commencing at the Mound at the South One-Quarter Section 23; Thence South 88½ Deg East 8.31 Chains to a Post; Thence North One Chain to a Post; Thence South 85¼ Deg West 5.89 Chains to a Post; Thence North One-Half Deg West 6.86 Chains to a Post; Thence North 88½ Deg West 2.19 Chains to a Post; Thence South 1½ Deg West 7.21 Chains to the Place of Beginning"

Design of "Skyway" and Observation Towers

Amusement Structure at the Century of Progress Exposition Has Unique Engineering Features

By William G. Grove

Member American Society of Civil Engineers

Robinson and Steinman, Engineers, New York, N.Y.

PERHAPS the most spectacular, and certainly one of the most popular amusements at the celebrated Century of Progress Exposition in Chicago is the "Skyride." Observation towers 600 ft high and 1,850 ft apart support a horizontal cableway system that transports passengers at a height 200 ft above the ground. This immense structure had to be planned to liquidate its investment in approximately five months. Of particular interest to the engineer, however, are the structural and operating problems so successfully solved, as described by Mr. Grove. The original paper, here abstracted, was delivered on June 30, 1933, at the Annual Convention in Chicago, before a joint session of the Structural Division of the Society and the Applied Mechanics Division of the American Society of Mechanical Engineers.

IN 1893 the outstanding mechanical feature of the World's Fair in Chicago was the Ferris wheel 300 ft in diameter, which revolved in a vertical plane. Now, 40 years later, in line with the idea of "A Century of Progress," the chief mechanical attraction has two features: first, a trip to the top of a tower over 600 ft high, or twice the height of the Ferris wheel, and second, a ride through space in a "rocket car" suspended from wire ropes 200 ft above the ground.

This idea of having a "Skyride" at Chicago was "sold" to A Century of Progress by W. C. Hamilton, a Scotchman who had operated a similar device in Great Britain. First a thorough investigation of the project was made from an economic point of view, by finding the percentage of patrons visiting the World's Fair in 1893 who actually took a ride on the Ferris wheel, and then estimating the number of 1933 visitors who would probably patronize the Skyride. After making due allowance for both the increase in Chicago's population and also for the economic depression of the last several years duration, five independent companies became convinced that participation in the project would be a profitable financial investment. These five companies, the Great Lakes Dredge and Dock Company, the Inland Steel Company, the Mississippi Valley Structural Steel Company, the Otis Elevator Company, and the John A. Roebling's Sons Company, entered into a contract with A Century of Progress to construct the towers, the elevators, the suspension-span cable system, and the rocket cars. The towers are 600 ft high and 1,850 ft from center to center, and the two horizontal cable systems are 75 ft apart.

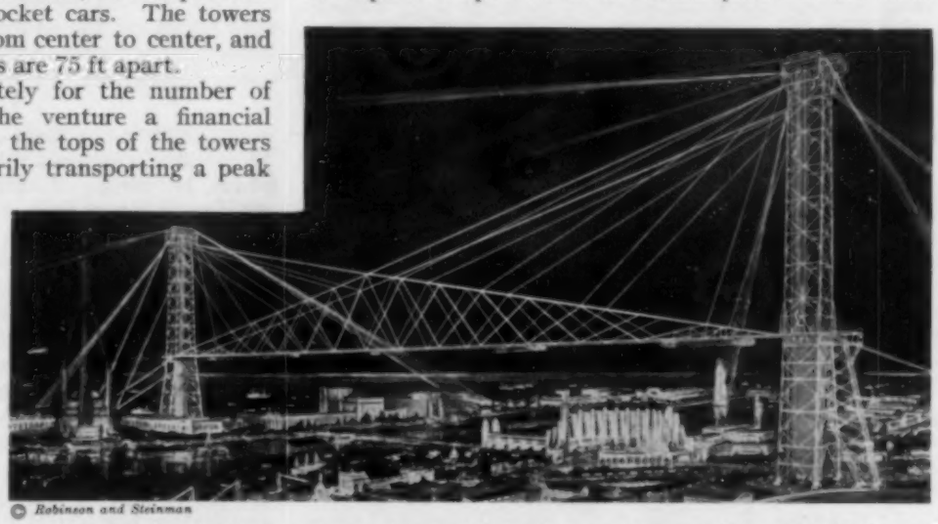
In order to provide adequately for the number of patrons necessary to make the venture a financial success, the elevator service to the tops of the towers had to be capable of satisfactorily transporting a peak number of 900 persons per hour in each of the two towers. Similarly, the elevator service to the 200-ft Skyride level had to be capable of handling a peak number of 3,000 patrons per hour, or 1,500 in each tower.

To meet these peak capacities, each tower is provided with two high-speed elevators operating at 700 fpm, each elevator having a maximum capacity of 20 people. The observation platforms at the tops of the towers have a capacity of 300, and it is assumed that the average length of time the patrons will remain on these platforms under peak operating conditions will be 20 min. The Skyway level is fed by two elevators in each tower, each elevator having a maximum capacity of 30 persons and operating at a speed of 500 fpm.

The rate of 3,000 patrons per hour fed by the Skyway elevators to the rocket cars determined the number, capacity, and operating speed of these cars. They are double decked, and their operation is so controlled that not more than three cars are on each side of the span at one time, the cars being kept as nearly as possible 500 ft apart while in motion from tower to tower. The cars are designed to seat 36 passengers exclusive of the operator. The number of cars in use is 10, and the dispatching interval is 1.4 min.

In the design of the towers, in line with the spirit of A Century of Progress, special consideration was given to welding as being representative of the most advanced methods of shop fabrication. The main columns consist of three I-beams welded together to form an H. Many of the tower bracing members are made up of a web plate and two channels welded together to form an I, the flanges of which are stiffened by additional welding of plates connecting the tips of the channel flanges to the main web plate of the member.

The principal departure from the conventional form of suspension spans is in the cable system of the main



© Robinson and Steinman

Two 600-Ft Towers 1,850 Ft Apart Support Cableway for Rocket Cars at 200-Ft Level
Four Elevators in Each Tower, Two for the Observation Platform and Two for the Skyride Level

span. Instead of the ordinary structural steel stiffening truss and floor system supported from wire cables by vertical wire-rope suspenders, the entire cable system is made up of twisted wire strands, in which every member is a tension member. The track ropes are supported at intervals varying from 80 ft near the towers to 160 ft at the center of the span.

COMPLETED TOWER OF SKYWAY

TESTS CHECK COMPUTED CABLE STRESSES

Before adopting the final profile of the cable system, a number of outlines were studied. The Roebling Company made a model one one-hundredth of actual size and conducted laboratory tests on several designs. After the final outline was decided upon, that company calculated the stresses in the various members comprising the system from observation and measurement of the deflections of the model, where weights, representing to proper scale the loaded rocket cars, were placed on the model in such positions as would give the maximum stresses in the members under consideration. In the meantime Robinson and Steinman calculated the stresses in the various members by the method of influence lines. In general there was a fairly close agreement in the stresses determined by these absolutely distinct and independent methods.

All the members of the cable system are of bridge-strand construction except the track ropes on which the rocket cars run, and these are locked, smooth-coil ropes. In order to remove the effect of inelastic deformation, all the strands were prestressed. The lengths of the ropes were computed at 62 deg normal temperature for a condition of live load in which one car was placed at midspan and one car 450 ft each side of midspan. After fabrication the various strands, except the track ropes, were placed in the prestressing machine at the Roebling plant, prestressed up to one-half their ultimate strength, and slacked off to the full dead load. They were then measured under this stress and finally cut to length and socketed.

Similarly, the track ropes were cut and socketed after being prestressed to an amount slightly above their working stress. If the track ropes had been prestressed to one-half their ultimate strength, the special smooth-coil wires, having a lower elastic limit than the cylindrical wires, would have been overstressed; and when the ropes were taken out of the prestressing machine these special wires would have regained their permanent set and would have bulged out.

At the tops of the towers the several diagonal ropes converge and meet on a single plate, which is supported from the front of the tower by means of a vertical link. The horizontal components of the cable stresses are carried by horizontal cables to a plate at the rear of the tower, and this plate is supported by another vertical link. From this rear plate the backstay cables extend down and are rigidly fastened to the concrete anchorages.

These vertical links at the tops of the towers provide for horizontal movement of the cable system due to stress and temperature changes of the various ropes comprising the system. Thus, instead of flexible towers with cables rigidly attached to them, there is a horizontal motion of the cable system on top of practically rigid towers. When the links vary from the perpendicular, the horizontal component of the stress is of course taken by the towers. A very important reason for keeping the towers rigid is to avoid interference with the successful operation of the elevators in their 600-ft shafts.

TRACK ROPES UNDER INITIAL TENSION

To decrease the sag of the track ropes when they are carrying loaded cars, these four ropes are placed under an initial dead-load tension of 240,000 lb, or 60,000 lb per strand. They are fastened to longitudinal trusses about 70 ft long, which are located at the lower corners of the cable system adjacent to the main towers. The opposite, or outer, ends of these trusses are connected to backstay ropes, which also extend down to the anchorages. Instead, however, of being rigidly secured to the main part of the counterweights, these backstay ropes are fastened to a structural steel frame which

TRIAL TRIP OF A ROCKET CAR

Cars Are Motor Driven Around the Towers; They Are Then Brought Up to the Speed of the Haulage Rope and "Gripped" to It for the Trip Between the Towers

is attached to the main anchorage by means of a hinge. This frame supports a steel box, filled with concrete which, by means of hinged counterweights, produces a practically constant tension of approximately 270,000 lb in the track ropes, regardless of the prevailing temperature.

These boxes are placed at such elevations that they will come to rest on supports should the horizontal movement become excessive in one longitudinal direction. Any tendency for further movement in that direction would result in a reaction under the box, thus tending to reduce the stress in the track ropes, but this would be counteracted by the counterweight at the opposite end of the bridge, thus preventing any reduction in the 270,000-lb tension of the track ropes and also preventing any further horizontal motion in that direction.

In addition, the diagonal cable system is attached to the 70-ft steel trusses so that the constant tension from

the backstay ropes is divided between the track ropes, the diagonals, and the hauling ropes for pulling the rocket cars. When one of the cars moves out on the track ropes, producing in them a live-load stress, there is a corresponding reduction of stress in the diagonal member of the cable system which is connected to the 70-ft truss.

The tower end of the 70-ft truss is supported on a hanging frame so as to permit free longitudinal motion in either direction. This frame supports the steel rails on which the cars operate at the unloading platform, around the ends of the towers, and at the loading platform.

CAREFUL DETAILS ENSURE SMOOTH RIDING

Special attention was given to the design of the joints in the lower cables of the system so as to get a satisfactory connection where the diagonal cables intersect at the track ropes. Zinc sleeves or buttons were cast on each track rope at each point of intersection. These sleeves fit in castings attached to the framework at the connection points, and proper provision is made for shims. Bent plate hoods about 2 ft long are fastened to these castings by means of pins, the hoods covering the track ropes. The outside ends of the hoods are tapered so that the wheels of the rocket car trucks can ride easily from the track ropes over the hoods. The pins are provided so that the hoods will follow the track ropes as the latter deflect during the passage of the cars. This whole detail was very carefully worked out and thoroughly tested at the Roebling plant so as to make sure that no difficulty would be encountered in the field during operation. A similar detail is provided where the track ropes join the 70-ft trusses.

During the trip from tower to tower the cars are operated by an endless hauling rope. When they approach the towers they are disconnected from the continuous rope and travel around the towers under their own motors, operated by electric current. Should a car be temporarily out of commission, provision is made at each tower for supporting the disabled car from a small transfer carriage and moving it out of the main operating circuit until repairs can be made. At each tower there is adequate space for two cars not in use.

Considerable study was given to the truck supporting the car from the track ropes, as there are four track ropes for each of the two cable systems. While on the trip between towers, the truck wheels bear on all four track ropes, there being eight wheels in action. When the cars are operating under their own power around the tower, on the curved rails, only the four inner wheels are in action.

The question of whether the car should be supported from the truck at one or two points was given careful consideration. It was realized that one pivot would be ideal if the center of gravity of the traveling car was absolutely fixed but that this condition would be impossible to maintain when the car was loaded with passengers. Furthermore, lateral and longitudinal wind forces and other vibrations would tend to make the car sway. Two points of support, on the other hand, would reduce the sway but would introduce complications at the curves. It was finally decided to retain all the advantages incident to one point of support and to limit the amount of longitudinal sway by automatic checks.

HOW THE SKYRIDE OPERATES

From tower to tower the cars are transported by means of continuous operating ropes. There are two units of this equipment, one for each cable system. This continuous rope moves at a speed of 520 fpm. Since the cars, after unloading, travel around the tower to the loading platform under their own power, there are periods when they must be attached to, and others when they must be disengaged from, the continuous rope. At such periods the car is loaded with passengers, so that it is important to effect the engagement and disengagement with the least possible jar.

For this purpose a special gripper was developed. This is operated electrically to connect the car to the continuous operating rope at the beginning of the trip, but it is operated mechanically to disconnect the car from the continuous rope when the car approaches the end of its trip. Should it be necessary to disconnect the car from the continuous rope while it is out on the cable system, provision is made whereby the operator can release the gripper by means of a hand rope.

ROCKET CARS PASSING AROUND A TOWER
The Normal Haulage Speed Between Towers Is 520 fpm

Furthermore, on account of the single point of support from the truck, it is necessary during the period of loading and unloading of passengers to lock the car temporarily in a fixed position to avoid any appearance of instability. In addition, the doors of the rocket car and those at the loading and unloading stations are electrically interlocked with the motors so that it is impossible to start the car while its doors are open.

MOTOR PROPULSION AT TOWERS

The sequence of operation is as follows: The Skyride elevators bring a group of passengers to the loading platform. A car is brought under its own power to the proper location and the car doors are opened, thus automatically cutting off the current from the operating motor so that the car is "dead." As soon as the passengers are in the car, the car door is closed, thus admitting current to the operating motor. The operator then starts his car and brings it to the speed of the continuous rope in a distance of 50 ft, or while the car is still on the 70-ft truss of the cable system. While car and rope are traveling at the same speed the car is attached to the operating rope by means of the thrusters at the gripper. It is then hauled across the span by means of the continuous rope. A complete telephone system is provided whereby the operator of each car can communicate with the towers while the car is in any position.

This unique amusement attraction has possibilities of development as a substitute for ferries at locations which require the construction of long spans, but where traffic is ordinarily very light. The total cost of the complete Skyway and observation towers was approximately one million dollars. The consulting engineer was Joshua D'Esposito, of Chicago, and the designing engineers were Robinson and Steinman of New York.

New Opportunities for the Engineer in City Planning

By D. H. Sawyer

Member American Society of Civil Engineers

Director, Federal Employment Stabilization Board, Washington, D.C.

IT is a commonplace that "hindsight" is a great deal more accurate, if less effective, than foresight. Experience in the past few years has emphasized the truth of this adage but has proved that proper planning is indeed possible in advance. The trend of the day is toward long-range planning. How this applies to city development is pointed out by Colonel Sawyer, whose arguments, aside from their reasonableness, are buttressed by his two years of experience as Director of the Federal Employment Stabilization Board. This article is abstracted from his paper read on June 30, 1933, before the meeting of the City Planning Division at the Society's Convention in Chicago.

THOSE engaged in the planning of physical improvements, whether for city, region, or state, are passing through difficult times. Officials, under tremendous pressure to reduce expenditures, have resorted to budget slashing, the effects of which are only beginning to be generally appreciated. Institutions and services fundamental to health, safety, and the general welfare of the public, which have taken many years to develop, are in danger of being undermined in the search for savings. The cry for a decrease in public expenses has been disquieting to the city planner because in many instances his activities have been curtailed or eliminated. Just as important is the fact that many of those in authority and those who pay the bills have concluded that the product of the planner's brain leads to additional expenditures in the future and hence should be dispensed with, at least for the time being.

This unfortunate misconception must be corrected and the important part which the planner has played in public affairs must be convincingly explained to the people. They should understand that the orderly growth of communities must be systematically directed by intelligent planning in order that the necessities and conveniences of modern life may be faithfully supplied. Only thus can the most judicious expenditure of the taxpayer's dollar be assured. To make the public realize these facts requires a persistent campaign of education and a tenacious adherence to the principle that the interests of the public can be served best by retaining and supporting this most important public service.

Some of the causes underlying present financial difficulties date back to the beginning of the practice of mortgaging the future to provide public improvements sooner than current income would permit. I am convinced that the results would have been less disastrous had our cities been wise enough to insist upon two prerequisites to the authorization of any debt obligation: (1) preparation of an official city plan for future development, and (2) formulation and periodical revision of a continuous public works program for the coordination and orderly execution of all improvements within the limits of the city's income. Such procedure, however, was probably too much to expect in the way of enlightened public interest at a time when urban sections were expanding rapidly and money was easy to find. There was a greater desire for immediate action than for deliberate consideration of the future.

STRAWS IN THE WIND

A number of significant indications should be recognized by those who are best fitted by training and experience to plan and guide the construction of future public improvements. Without elaboration or supporting arguments, the following may be cited:

1. Federal legislation to create a Tennessee Valley Authority has been enacted and presents unusual opportunities for regional and community planning on a large scale. The "authority" has been appointed and preliminary preparations are under way.

2. The Federal legislation for industrial recovery has possibilities of stimulating various forms of planning.

3. Bills presented recently to the legislatures of six states provided for advance planning of public works.

4. Administration of advance planning and programming functions by a board to be appointed by the governor is contemplated in several states.

5. The Federal Government and the District of Columbia plan and program all construction six years ahead.

6. Of the cities that have endorsed the principle of advance planning and programming of public works, at least nine are preparing comprehensive programs.

7. Various national and local associations have endorsed advance planning by resolution and otherwise.

8. Eight national organizations are seriously concerning themselves with the promotion of advance planning and programming of public works. At least one of them is advocating the coordination of planning by cities, counties, states, and the Federal Government.

9. The National Land Use Planning Committee is directing its efforts toward the formulation and adoption of a more constructive land policy for the intelligent conservation, development, and use of public and private lands.

10. The President has repeatedly emphasized the need of more far-sighted planning in government, industry, and business.

The items in this list, which is by no means complete, should have considerable significance for those who encourage planning. I believe that the leadership, direction, and administration in some of these matters at least, should be exercised by those of the engineering and city planning professions. Even if no one of these items had any significance to the engineer and city planner individually or to the profession as a whole, in the aggregate they would express the temper of the times. The belief is gaining ground that someone, somehow, must find a better solution to the riddle of providing for public works within the pocketbooks of those who foot the bills. The time has come when we must recognize the seriousness of the perplexities that face public bodies,

not only in maintaining, repairing, and operating those physical enterprises which are basically essential to community life, but also in providing for interest on debts and the maturity of obligations.

SIGNIFICANCE OF FEDERAL PROGRAM

At the moment we are witnessing the launching of a tremendous public works program initiated by the Federal Government and to be executed by funds provided by it. This effort is part of a broad-gage program to resuscitate business and industry. The unfolding of this program can be of tremendous help in curbing the unemployment that stalks in the land; but to fulfill this specification, there must be leadership and guidance in order that this vast expenditure may find its way into legitimate channels for the welfare of communities and so that, as far as possible, it may add little or no additional expense to government beyond the cost of construction.

In evolving this program, local difficulties in the selection of projects have arisen that might easily have been avoided if in days gone by more consideration had been given to securing a proper adjustment between anticipated future physical necessities and financial restrictions. I have reference to the advance planning and programming of public works which during the past two years has gained in momentum until it seems destined to become an integral part of public administration in state and local government, just as it now is in the Federal Government.

By the programming of public improvements is meant the process of formulating and annually revising a balanced and comprehensive program of all the physical improvements to be undertaken by a community for a definite number of years in the future in accord with its financial resources. Such a program should display projects in terms of their estimated cost, allocated to definite years, in the order of their urgency. Where possible it should suggest sources from which funds could be secured. No one can question, I think, the logic of this method of exercising control over the disbursement of public funds.

Changing economic and social conditions and rapid urban expansion have demonstrated the need for long-range planning. Its acceptance in the United States is evidenced by the existence of 865 official planning commissions, of which 59 are county and regional and 806 are city planning bodies. In addition, there are 23 unofficial regional planning organizations. A city or regional plan, establishing the framework of the city, stamping the character of the uses to which the land shall be put, and properly coordinating anticipated public improvements, is essential to well-rounded community betterment.

The widespread interest that has developed in the advance planning and programming of public works began to gain momentum about three years ago when agitation was renewed for its application to Federal construction, which resulted a year later in enactment of the Federal Employment Stabilization Act of 1931. The board created by this law has as one of its duties that of cooperating with the construction agencies of the Federal Government and the District of Columbia in formulating advance plans for all construction, including maintenance and repairs, six years ahead. An essential requirement of the law is that these plans shall be annually revised and extended for an additional year, thus establishing planning continuity year after year.

During the two years of the board's existence it has been possible to evolve and test the means to be pursued in planning public improvements several years in advance. The material supplied to the board relates to the location and character of work, its total estimated cost, its estimated cost during the six-year planning period, the allocation of this amount to definite years, the maximum cost prescribed by Congress, whether or not it has been authorized, the annual expense of maintenance and repairs, the cost and status of acquiring the necessary sites and lands, status of plans and specifications, and other relevant information necessary to exercise judgment, depending on the character of program which seems to be requisite.

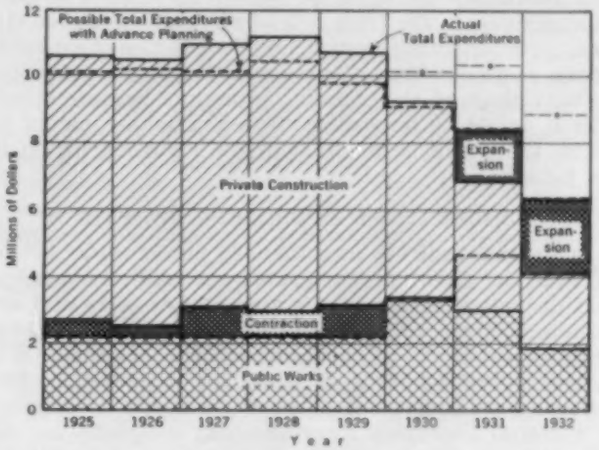


FIG. 1. ESTIMATED CONSTRUCTION EXPENDITURES IN THE UNITED STATES WITH AND WITHOUT ADVANCE PLANNING IN OPERATION

Difference Between Stars and Dollar Expenditures Is Due to Declining Construction Costs

The experience of the board has proved the wisdom of the legislation and demonstrated that heads of construction agencies are not only able and willing to supply the essential data six years ahead, in the form of schedules of their physical requirements, but are capable of expressing superior judgment as to what parts of their programs should be given emphasis. It has further proved that the accumulation of these data in systematic, understandable form and the planning of schedules for years to come have been of great assistance in the conduct of the regular work of the agencies themselves.

THE CAPITAL CITY AS AN EXAMPLE

Of course the methods to be followed in programming public works will vary according to local conditions. The City of Washington has furnished an opportunity to test the application to a municipality of the principles involved. I wish to point out a few important matters relating to procedure which are based on this experience.

First of all, responsibility for formulation of the program and prosecution of the necessary studies should be definitely established in an existing agency or one created for the purpose. This agency should include in its membership the director of finance, or treasurer of the city, or some other responsible financial officer; the city engineer or director of public works, or both; a representative of the school board; a representative of the city planning commission; a leading local banker; and a leader in the construction field. It will prove desirable to invite the cooperation of all agencies having charge of any construction, repairs, or alterations, and of unofficial organizations equipped to render assistance and advice. Official sanction for preparing a comprehensive public works program should be secured by ordinance or by request to the responsible authority.

The period to be covered by the program should be established; it will probably range from five to ten years. For uniformity in reporting and to facilitate tabulation, analysis, and presentation, it will be necessary to prepare forms on which the agencies will submit their schedules.

In formulating a comprehensive program, study must be given to such factors as growth of population and business activity and past and future trends of municipal income and outgo. Likewise the cost of the projects recommended must be studied in relation to past expenditures, to the total cost of all projects, and to the total governmental expenses. The prediction of probable future revenues from various sources is a vitally important phase of the planning procedure because otherwise it would be impossible to determine the extent to which funds will be made available for construction in the future.

CONSIDERATIONS IN CHOOSING PROJECTS

Successful results in programming public works will be attained in direct proportion to the skill, knowledge, and discretion shown in selecting the projects and determining their proper sequence. Obviously, all the projects will not be of equal importance. Therefore it is necessary to establish a basis for judgment. The following are some of the factors that have been found of material assistance in establishing programs for the relief of unemployment:

1. Projects under construction or under contract, which must be completed if financial loss to the Government is to be avoided.
2. Projects necessary for the protection of life, health, and property; for the housing of governmental activities; to sustain the physical property of the government; for the reconditioning of existing structures; for replacement of necessary facilities now obsolete; and for the conservation of national resources.
3. Revenue-producing projects.
4. Types of work that do not entail annual Federal expense for either physical upkeep or operating personnel and facilities, or both.
5. Projects that are designed, for which sites are available or can be quickly acquired, and for which contracts can be awarded at an early date, to give early employment to the maximum number of men.
6. Projects close to centers of unemployment.
7. Projects that promptly call for material and equipment produced in centers of unemployment.
8. Projects not dependent upon seasonal conditions.
9. Projects that do not employ wards of the Government.
10. Projects that might be wholly or partially manned by unemployed.
11. Projects that represent Government policies of programming construction six years in advance.

Last, but not least, the program should be periodically revised and extended to keep it always a given number of years ahead and to adapt it to changing conditions. Preferably this should be done annually because it will tend to make the planning function a continuous one, encouraging the agencies to study their requirements constantly, and thus make planning a more integral part of the daily administration of public business. This cannot fail to strengthen the city plan.

There is urgent need for thorough stock-taking—for the examination of present financial practices with respect to both the raising and the expenditure of funds. Studies must be made to determine wherein methods are faulty, and corrective measures must be adopted if city planning and other essential community services are to be maintained. In other words, there must be more rational planning in all phases of public administration, as well as in the future physical development of the community. This planning must be based on adequate surveys and on studies of probable future resources and requirements. The depression has demonstrated this fact beyond a doubt. More thought must be given to securing a better balance between the expenditures for various community services and improvements by impartial appraisal of their relative importance and value to the community. Likewise, these expenditures must be so controlled that they will not exceed the reasonable financial resources of the community.

There lies before us as engineers and city planners an unparalleled opportunity to broaden the scope of our activities and to demonstrate the need for this more comprehensive approach to community problems. By so doing we not only will aid materially in reestablishing confidence in city and regional planning, but will render a valuable service in the entire field of public administration.

Photograph Courtesy H. P. Treadway, M. Am. Soc. C.E.

PERMEABLE DIKES ON THE MISSOURI RIVER, DESIGNED BY THE U.S. CORPS OF ENGINEERS FOR CHANNEL CORRECTION AND PREVENTION OF LAND DESTRUCTION
Council Bluffs Iowa, on the Left; Omaha, Nebr., on the Right

Pollution of Lake Michigan

A Serious Menace to the Safety of the Water Supply of Metropolitan Chicago

FOUR million people in the metropolitan district of Chicago are furnished with domestic water from Lake Michigan. The growing industrial area around the southern end of the lake disposes of both trade and domestic wastes by discharge into the Calumet River and also directly into the lake. These wastes often drift north to the Chicago intake cribs where certain ones, especially those from oil refineries, absorb and neutralize the chlorine added to the water as a protection against sewage pollution. Not only is the bacterial sterilizing agent thus removed, but offensive taste- and odor-producing compounds enter the distribution system. The industries are cooperating in the proper handling of their wastes, but the municipalities in the industrial area have done but little towards the safe disposal of their domestic sewage. In these articles, abstracted from the complete papers read before the Sanitary Engineering Division of the Society on June 30, 1933, during the Annual Convention in Chicago, Mr. Gorman and Mr. Baylis present the problem in all its seriousness. Mr. Gorman emphasizes the necessity for the adoption of a program of correction which will be operative before 1939, when the diversions to the Chicago Drainage Canal must be reduced to 1,500 cu ft per sec. A new method of studying industrial wastes is presented by Mr. Baylis.

Survey of Sources of Pollution

By ARTHUR E. GORMAN

ENGINEER OF WATER PURIFICATION, CITY OF CHICAGO

FOR over 25 years the seriousness of the pollution of Lake Michigan has been realized, and surveys by state officials of Indiana and Illinois as well as by the U.S. Public Health Service have conclusively shown that serious hazards to public health exist. Only through the excessive use of chlorine are the public water supplies in East Chicago, Whiting, Hammond, and at times the southerly parts of Chicago made safe for domestic use.

These surveys have clearly indicated that the major source of pollution is the sewage and industrial wastes discharged through the Indiana Harbor Ship Canal and along the lake front west of the canal. Pollution from a secondary source—the Calumet River—has been materially reduced since 1928. The Sanitary District of Chicago has accomplished this reduction by treatment of the sewage of the Calumet region of Illinois and by dredging of the Calumet River and its tributaries, the Grand and Little Calumet rivers, so that they normally flow away from the lake via the Calumet Sag Channel.

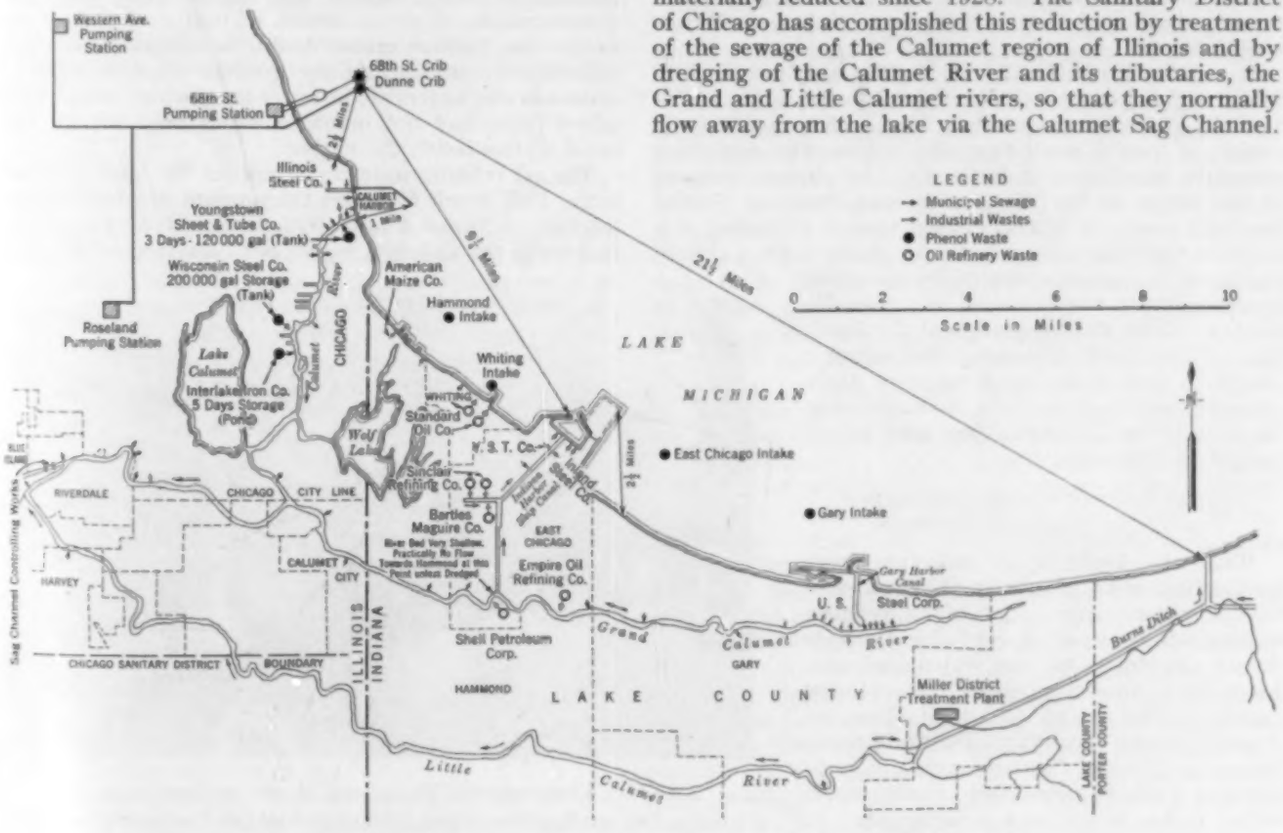


FIG. 1. MAJOR SOURCES OF POLLUTION IN THE SOUTHERN END OF LAKE MICHIGAN

The location of the sources of pollution and their relation to the water supply intakes are shown in Fig. 1.

SERIOUS TYPHOID OUTBREAKS

Penalties for the unjustified disposal of sewage into Lake Michigan were paid by South Side Chicagoans late in 1923 when an outbreak of typhoid resulted in 227 cases and 23 deaths. In the following year, in the city of Hammond the toll in lives of victims to water-borne typhoid was 21, following interrupted chlorination. But even these tragic occurrences have not forced the

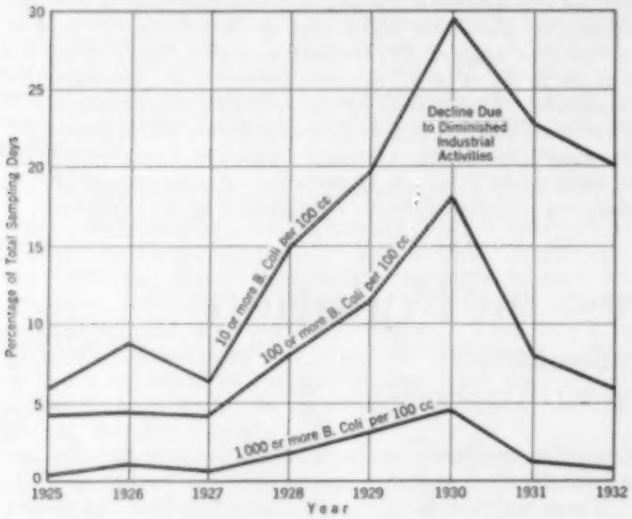


FIG. 2. BACTERIAL POLLUTION OF LAKE MICHIGAN WATER AT THE DUNNE CRIB, AN INTAKE OF CHICAGO'S DISTRIBUTION SYSTEM

adoption of remedial measures adequate to safeguard the public water supplies. In Fig. 2 is shown the bacterial pollution of Lake Michigan at Chicago's Dunne Crib intakes.

It was not until after the city's water supply at the 68th Street and Dunne cribs became so polluted in December 1927 by phenolic wastes that it was undrinkable for a period of over a week that any noteworthy corrective measures were taken in Indiana. The phenolic content of the water at the Western Avenue Pumping Station was 63.2 parts per billion at that time. Following this incident the three by-product coke plants in the Calumet region of Indiana cooperated by installing equipment for the disposal of phenolic wastes. With the assistance of the Sanitary District of Chicago, two similar plants in Illinois arranged to store their phenolic wastes when there is danger that the flow of the Calumet River may be reversed into the lake.

OBJECTIONABLE TASTES AND ODORS IMPARTED TO WATER SUPPLIES

With the lessening of pollution from by-product coke plants in 1929, a new taste problem arose, that of oil refinery wastes, which impart a very objectionable musty-oily taste to the water and also have the power of absorbing chlorine rapidly. The extent to which these industrial wastes have caused objectionable tastes in Chicago's water supply is indicated in Table I, a summary of the periods when tastes have been objectionable at the Dunne Crib intakes since 1927.

Between November 10 and 26, 1931, oil refinery wastes discharged from and near the Indiana Harbor Ship Canal drifted north more than 50 miles along the shore of Lake Michigan to Waukegan, Ill. On this occasion the typical musty-oily taste appeared in most of the public water supplies taken from the lake all the way from Whiting to Waukegan, used by 4,000,000 people.

TABLE I. OFFENSIVE TASTES AT THE DUNNE CRIB INTAKE
Number of Periods and Their Total Length in a Given Year

	Chloro-Phenol Taste		Musty-Oily Taste	
Year	Number of Periods	Total Day	Number of Periods	Total Day
1927	1	4	.	.
1928	7	10	.	.
1929	8	17	.	.
1930	7	18	3	9
1931	2	3	5	15
1932	1	11	7	22
Total	26	63	15	46

Between December 21, 1932, and January 5, 1933, there was a most serious pollution of Chicago's water supply by industrial waste accompanied by the characteristic chloro-phenol taste. Investigations in the lake and on the river definitely indicated the Indiana Harbor Ship Canal as the point of discharge of these wastes into the lake. The major source was found to be the waste discharged from a large oil refinery located on the Grand Calumet River just east of its junction with the canal. The degree of phenol pollution in the water at the 68th Street Crib was about 13.0 parts per billion.

Low lake levels, freezing over of the Ship Canal, a thaw, and the drift of phenol-polluted ice fields past water works intakes under the influence of continued southerly winds, are considered to have been the circumstances which caused this serious pollution. The concentration of these wastes in and under sheet ice inside the harbor undoubtedly accentuated the lake pollution by preventing the gradual dispersion of the wastes in the waters of the outer lake, which would have taken place had not on-shore winds held the ice and canal waters inside the harbor.

The oil refining industry admitted its fault and has since done much to lessen the amount of phenols in its wastes. A broad cooperative survey of all the oil refineries in the Calumet region has been worked out with

SCENE AT EXPERIMENTAL FILTRATION PLANT ON JANUARY 2, 1933
During Two Weeks of Bad Tasting Water, Six to Ten Thousand Chicagoans Daily Obtained Free Filtered Water at This Plant

the Indiana and Illinois state departments of health, the City of Chicago, the Sanitary District of Chicago, and the American Petroleum Institute.

As a result of rapid industrial development in the Calumet region between 1927 and 1930, the pollution has increased in the waters of the southern end of the lake between the mouth of the Ship Canal and the Chicago intakes. The decrease in the amount of pollution since 1930, indicated in Fig. 2, can be attributed to the effects of the depression—a reduction in both working population and the volume of industrial waste.

The seriousness of the pollution caused by infectious matter in domestic sewage is doubly great because certain of the industrial wastes absorb the chlorine applied to protect the public health. The hazard of excessive chlorine absorption is indicated in Table II, which summarizes the 155 periods during the eight years of 1925 to 1932, inclusive, when the effectiveness of chlorination at Chicago was lessened by absorption.

The period of objectionable taste in Chicago's water last winter stirred the public to indignation. At the experimental filtration plant from 8,000 to 10,000 citizens called daily for over a week to obtain the palatable filtered water which is dispensed free to the public. South Side aldermen in the City Council introduced resolutions calling on the Corporation Counsel to take legal action to stop the pollution of the lake, and directed the Commissioner of Public Works to make studies and report on the cost of filtering the water supplied to the South Side. In the Illinois State Legislature a resolution was passed directing the Attorney General to investigate and report back to the assembly on the legal aspects of lake pollution. The result of a phenol survey made on December 27, 1932, is shown in Fig. 3. In Fig. 4 is presented a diagram of the proposed method of applying ammonia and chlorine to the South Side water supply at the Dunne Crib.

TABLE II. NUMBER OF PERIODS WHEN THE EFFECTIVENESS OF CHLORINATION WAS REDUCED BY TRADE WASTE ABSORPTION

Year	Number of Periods	Year	Number of Periods
1925	8	1929	34
1926	32	1930	13
1927	11	1931	20
1928	22	1932	15

Through the Indiana Harbor Ship Canal the lake is now receiving the untreated sewage of about 90,000 people in Gary, 55,000 in East Chicago, and 4,000 in Hammond. Whiting discharges the untreated sewage of about 10,000 more directly into the lake. This makes a total of 159,000 of contributing population from which sewage reaches the lake in the vicinity of the Ship Canal. The untreated sewage of about 50,000 people in Hammond reaches the Grand and Little Calumet rivers and is normally diverted to the Sag Canal.

From these data it will be seen that the pollution of the lake from Whiting and the Ship Canal is most serious. It is but 9¼ miles from the Indiana Harbor outlet to Chicago's most southerly intake. Float studies have indicated that the drift of surface pollution in the lake may average about one-half mile per hour with average winds. The prevailing wind in the Chicago region is southwest, which occurs over 31 per cent of the time. Southerly winds prevail about 12 per cent of the time.

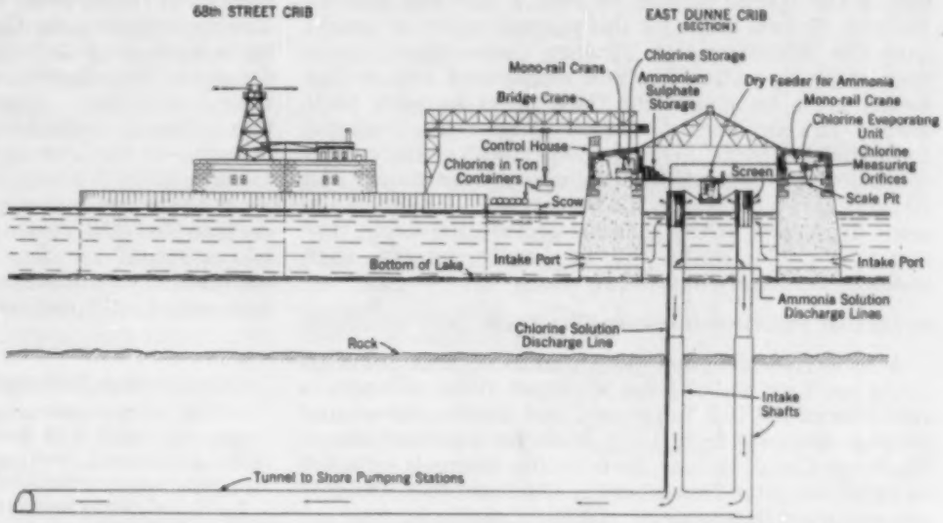


FIG. 4. PROPOSED EQUIPMENT FOR APPLYING CHEMICALS AT DUNNE CRIB INTAKE

Thus winds from these two directions occur over 43 per cent of the time. Southerly winds are most frequent in the fall and winter months, when water temperatures are low and the biological oxidation of industrial waste is retarded. Rarely are phenolic tastes found in Chicago's water when the temperature is over 50 F. The winter season is also the period when ice fields may develop, and if polluting material is frozen in them, concentrated contamination will occur in limited areas where the ice floats and melts.

The State Board of Health of Indiana and the cities in the Calumet region of Illinois have been aware of the seriousness of the lake pollution for many years and have given it occasional study. Little has been done by Indiana cities toward the removal of domestic sewage from Lake Michigan. However, the fact remains that ultimately the problem of sewage and industrial waste must be solved to prevent major harm to the public health in Lake County, Indiana. To permit the pollution to increase will be to invite a catastrophe.

In 1924 the Indiana State Board of Health passed regulations prohibiting pollution of any lake in the state by the discharge of sewage or industrial wastes which had not been sufficiently treated, the order to become effective January 1, 1926. Shortly afterward the cities of Hammond, Whiting, and East Chicago jointly retained engineers to report on a sewage disposal system for the region, and a report was submitted to the Indiana State Board of Health.

In 1927 the Indiana Legislature passed a stream pollution control bill, but by a special provision of the act it did not apply to Lake Michigan or to streams flowing into it. On December 10, 1927, the Indiana State Board of Health issued a special order to the four cities of the Calumet region requesting the construction of sewage treatment works. Whiting and Hammond pointed out the impossibility of financing such works under existing laws and suggested that enabling legislation be obtained. Plans for sewage treatment at Gary were approved in 1929 by the Indiana State Board of

Health. A sanitary district formed in East Chicago in 1929 to construct sewage treatment works has done nothing to date in this regard and is threatened with dissolution.

In 1931 the Indiana Legislature refused legislation for financing the construction of sewage treatment projects, but in the special session of 1932 a law was enacted whereby Federal funds for this purpose might be sought from the Reconstruction Finance Corporation. However, this corporation has now evaporated and further means must be sought for these cities to solve their sewage and drainage problems. Under the National Industrial Recovery Act only 30 per cent of the cost of construction is granted by the Federal Government and 70 per cent is a burden on the taxpayers. Because of the acute depression in the Calumet region, it is likely that any new public works will be locally opposed until business has greatly improved.

EFFECT OF DECREASED DIVERSIONS FROM LAKE MICHIGAN

A dangerous situation lies ahead as regards pollution in the southern end of Lake Michigan. One difficulty is the order of the U.S. Supreme Court limiting the annual average diversion from Lake Michigan via the Chicago Drainage Canal and its contributing channels to 5,000 cu ft per sec after December 31, 1936, and to 1,500 cu ft per sec after December 31, 1938. Considering the hydraulic condition which makes the diversion through the Calumet River and Sag Channel about one-fourth that through the main Chicago Drainage Canal, the Calumet River after 1938 certainly will discharge into the lake at South Chicago off 92d Street much of the time and will always do so after rains. This means that the pollution in the Calumet River now diverted through the Sag Channel, including untreated sewage from nearly 50,000 people in Indiana, will frequently reach the lake front only $2^3/_4$ miles south of Chicago's most southerly intakes. Unless the pollution is checked in the meantime, such a condition will be very serious for Chicago.

The second dangerous condition pertaining to pollution of the lake front from the Ship Canal is the proposed harbor and industrial developments at the mouth of the canal. When first built in 1901 the canal was a private enterprise. Later it was taken over by the U.S. Government. For the protection of the harbor a breakwater was built with liberal openings along shore, both to the east and west, as well as to the outer lake through the harbor entrance. Thus pollution from the Ship Canal drifted eastward toward the East Chicago and Gary intakes with northerly winds; northward toward the Whiting, Hammond, and Chicago intakes with southerly winds; and out into the lake via the harbor entrance with westerly winds.

Permits issued to industry to fill in the lake resulted in the closing off of the northerly shore outlet from the harbor. Also the southerly gap has been considerably reduced in recent years and soon will be entirely closed. The result is that the Gary and East Chicago water intakes have received valuable protection from the Ship Canal and its pollution, most of which originated within their own borders. Conversely, the pocketing of pollution within the outer harbor of Indiana has caused heavy pollution of the lake to the north and west and in the vicinity of the Whiting, Hammond, and Chicago intakes. From the sanitary survey conducted last December, it is certain that the exceptionally heavy pollution of the lake north of the Ship Canal resulted from pocketed pollution of ice and water in the outer harbor, which was not evident until southerly winds occurred.

IMPORTANT CONCLUSIONS DRAWN

In conclusion, it is time to reiterate the following facts:

1. One of the most serious problems of interstate waterway pollution in the United States today exists at the southern end of Lake Michigan, affecting the water supply of over 4,000,000 people in the metropolitan region of Chicago in Illinois and Indiana.
2. Unless radical measures are taken to check the pollution of the lake by both industrial wastes and domestic sewage from the municipalities in the Calumet region the danger of a typhoid fever outbreak in northern Indiana will increase, and will become particularly acute after December 31, 1938, when by order of the U.S. Supreme Court, diversion of water from Lake Michigan must be reduced to 1,500 cu ft per sec.
3. Pollution from industrial waste is serious because of tastes and odors imparted to public water supplies, as well as because of the high chlorine absorptive powers of certain wastes. The cooperation received from industry in abating pollutional nuisances has been and still is most encouraging.
4. Municipalities in the Calumet region of Indiana have discussed sewage disposal for the past twenty years, but as yet no definite constructive program has been adopted. Unless prompt action is taken and works are put in operation before 1939, a very serious situation will exist, jeopardizing public health in the entire metropolitan region of Chicago.
5. The situation as regards pollution of the lake and contributing waterways in Illinois, while not wholly satisfactory for a program of restricted diversion, is much more satisfactory than that in the Calumet region of Indiana, both as to sewage treatment and disposal of industrial wastes.
6. A real opportunity is offered for constructive cooperation between public officials in both Illinois and Indiana and industry, to clean up a condition which otherwise may develop into a serious menace to the public health.

Effect of Certain Industrial Wastes

By JOHN R. BAYLIS
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PUBLIC water supplies taken from Lake Michigan by the communities between Gary, Ind., and Waukegan, Ill., may at times be affected by trade wastes entering the lake. The cities affected to the greatest extent are Gary, Whiting, East Chicago, and Hammond, in Indiana, and that part of the South Side of the City of Chicago which receives water from the Dunne Crib intake. Tastes and odors resulting from industrial pollution may be expected in these supplies a number of times throughout the year. At Whiting and Hammond, where the intakes do not extend very far into the lake, the water almost always has a readily noticeable taste and odor. The periods when a taste is noticeable at Gary, East Chicago, and the Dunne Crib intake for the City of Chicago occur much less frequently, and the intensity of the taste and odor is not nearly so great as at Whiting and Hammond.

The main effect of trade wastes on the quality of the

water is to produce tastes and odors. If these are removed in the treatment plants, not only is the cost of treating the water increased, but sudden increases in the chlorine absorption constitute a serious hazard in that the chlorine applied may all be absorbed before complete sterilization has been accomplished.

DIFFICULTIES OF REMOVING TASTES AND ODORS

The number of chemical compounds which produce objectionable tastes and odors may be very extensive for certain trade wastes; yet with the exception of phenol there is almost no knowledge of them. It is not possible to analyze a sample of trade waste and determine the exact amount of objectionable constituents it contains. The best that can be done is to dilute the raw water with water that is free from the taste- and odor-producing compounds to determine the point at which the taste or odor is just detectable. This point of concentration varies very widely. Some substances will produce an objectionable odor when the concentration is less than 0.001 ppm; whereas others may require several parts per million.

Since the substances which may reach any of the intakes are greatly diluted with lake water, it is believed that a determination of the taste or odor threshold point of the various wastes will be of great value in determining the objectionableness of the waste. Only a few of the compounds occurring in the trade wastes that have been examined produce a more intense odor after the addition of chlorine than before. Consequently most of the tests were made without the use of chlorine, a procedure which greatly simplified the work. By determining the concentration of phenol in the waste and the odor threshold point by dilution with odor-free water, very good information on the objectionableness of a substance was obtained. The presence of phenol was determined by chemical tests.

To obtain accurate results from odor determinations it is essential that the procedure here described be followed as closely as possible. The dilution water should be free from all taste- and odor-producing compounds, and especially those present in the water to be tested. This means that the dilution water must not contain any of the substances which in higher concentrations will give off an odor. The best method of obtaining such water is to take clear filtered water which is reasonably free from tastes and odors and pass it slowly through a deep bed of granular activated carbon. A type of carbon unit suitable for producing odor-free water is shown in Fig. 1. A good grade of granular activated carbon, such as hydrodarco, nuchar, or cocoanut char, should be used.

Fairly satisfactory results may be obtained by adding powdered activated carbon to the water and later removing it by filtration. A well washed plug of absorbent cotton packed in the bottom of a glass funnel will form an effective filter. Filter paper usually imparts a slight odor to the water and should not be used. It is believed best to use 200 to 400 ppm of the powdered carbon and to agitate the mixture of water and carbon for at least ten minutes before filtering.

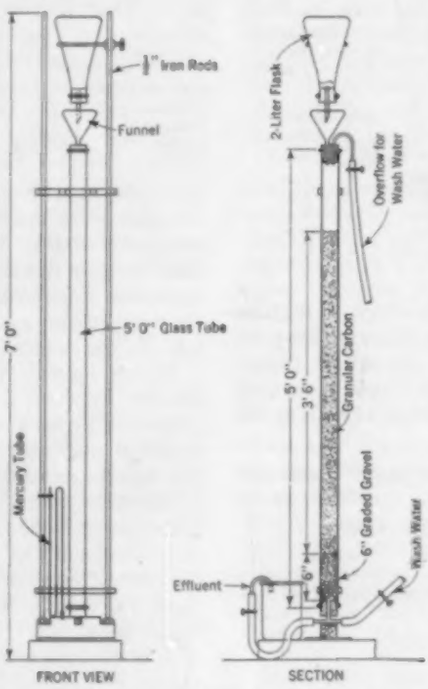

FIG. 1. LABORATORY CARBON FILTER FOR PRODUCING ODOR-FREE WATER

Glassware must be cleansed very thoroughly before using. After the desired dilutions of the sample have been made with odor-free water, about 250 cc of each diluted sample is placed in a 500-cc Erlenmeyer flask. The cold odor determination test should be made at a temperature between 20 and 25 C. The nosepiece shown in Fig. 2 is used for making the test. This should be ground to fit the nose of the person making the test, so that when it is in place all the air entering the nostrils will pass through the tube. It should be cleansed thoroughly and kept submerged in odor-free water when not in use, if extreme accuracy is desired.

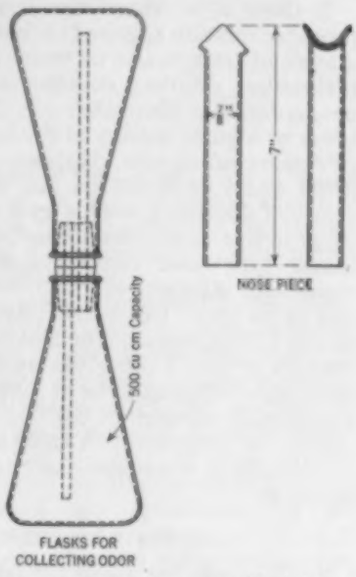

FIG. 2. ODOR-TESTING APPARATUS

When ready to make the cold odor test, the experimenter places a watch glass over the flask and agitates the water vigorously for several seconds. This brings the water and the air within the flask in close contact. If the water contains substances which will give off an odor, they impart it to the air inside the flask. The nosepiece is then placed against the nose so that no air can enter except through the tube; the watch glass is removed; the end of the nosepiece is extended into the flask to a point about one-half inch above the water level; and then the air is inhaled. In this manner air diluted but very little by the surrounding air will be drawn into the nostrils. The intensity of the odor is recorded according to the method of measurement recommended in *Standard Methods of Water Analysis*, such as very faint, faint, distinct, decided, and very strong. The odor is also given some classification such as musty, oily, gasoline, or chlorophenol.

To make the hot odor test, the water should be heated to a temperature of approximately 70 C, and the same procedure used as for the cold odor test. This temperature is about as high as can be used without danger of burning the nostrils. If a higher temperature is desired, it is advisable to use the double flask shown in Fig. 2. First the water is heated in one flask; then the second flask is attached; the water is distributed so that about half of it is in each flask; the flasks are shaken thoroughly; and the water is allowed to run into the lower one. The air in the upper flask is then allowed to cool enough so that it can be breathed without danger of burning the nostrils. Usually it is not necessary to heat the liquid to a temperature above

70 C, and it is believed that practically all tests can be made without the use of the double flask.

DETERMINING THE ODOR THRESHOLD POINT BY DILUTION

If there is no knowledge from previous tests of the probable dilution required to find the threshold point of a sample of trade waste or water polluted with it, several preliminary dilutions covering a fairly wide range must be made. To illustrate: if the sample is from the sewer of a plant known to discharge objectionable odor-producing substances, dilutions of 1 in 99, 1 in 999, 1 in 9,999, and 1 in 99,999 are first made. Assume that the 1 in 999 dilution gives an odor and the dilution of 1 in 9,999 is free from odor, then the threshold point is between 1,000 and 10,000. Another series of tests is made with dilutions of 1 in 1,999, 1 in 3,999, 1 in 5,999, and so on up to 1 in 9,999. Assuming that the dilution of 1 in 5,999 gives an odor that is just detectable, but the dilution of 1 in 7,999 gives no odor, then the threshold point may be taken to be at a dilution of 1 in 5,999, or at a threshold number of 6,000. If desired, dilutions between 1 in 5,999 and 1 in 7,999 may be made and tested, but usually it is not necessary to make so exact a determination.

ODOR TESTS ON INDUSTRIAL WASTES

To illustrate the use of the odor test to determine the objectionable qualities of waste products from certain industrial plants, typical tests are given in Tables I and II. It will be noted that a very much higher dilution is required to find the odor threshold point in the hot solution than in the cold.

In Table I are given the results of a test on a concentrated solution from an industrial plant. It is evident that if a large amount of this material reached the lake, it would impart a noticeable odor to a considerable volume of water. The sample was taken from a certain part of the plant, and the amount of waste from this part is small compared to the waste from the whole plant. This is illustrated by a comparison with Table II, which is for a composite sample of the waste from the plant for a period of one week. The hot odor test has a threshold number of 1,200, which shows that if the waste is diluted in more than 1,200 parts of water it will produce no objectionable odor unless the dilution water contains some of the compounds present in the waste.

TABLE I. ODOR DETERMINATIONS ON A HIGHLY CONCENTRATED TRADE WASTE

Threshold Number: Cold, 300,000; Hot, 900,000

SYMBOLS USED

a = aromatic; o = oily; 0 = no odor; 3 = distinct
m = musty; s = sulfide; 1 = very faint; 4 = strong
2 = faint; 5 = very strong

Dilution	Odor Cold (20 C)	Odor Hot (70 C)	Dilution	Odor Cold (20 C)	Odor Hot (70 C)
1 in 1,000	5 os	5 os	1 in 350,000	0	2 os
1 in 10,000	3 os	5 os	1 in 500,000	0	1 os
1 in 100,000	2 os	3 os	1 in 800,000	0	1 os
1 in 200,000	1 os	2 os	1 in 900,000	0	1 os
1 in 300,000	1 os	2 os	1 in 1,000,000	0	0

TABLE II. ODOR DETERMINATIONS ON A WEEKLY COMPOSITE SAMPLE OF WASTE FROM THE SEWER OF AN INDUSTRIAL PLANT

Threshold Number: Cold, 600; Hot, 1,200

Dilution	Odor Cold (20 C)	Odor Hot (70 C)	Dilution	Odor Cold (20 C)	Odor Hot (70 C)
1 in 500	1 os	2 os	1 in 1,000	0	1 os
1 in 600	1 os	2 os	1 in 1,200	0	1 os
1 in 700	0	1 os	1 in 1,400	0	0

In Table III are given the results of a test on a sample of water collected at the outlet of a sewer emptying into Lake Michigan. This sewer is believed to contain waste from a corn products plant.

TABLE III. ODOR DETERMINATIONS ON A SAMPLE OF WATER FROM A SEWER EMPTYING INTO LAKE MICHIGAN

Threshold Number: Cold, 8,000; Hot, 10,000

Dilution	Odor Cold (20 C)	Odor Hot (55 C)
1 in 5,000	2 sa	3 sa
1 in 6,000	1 s	2 sa
1 in 7,000	1 s	2 sa
1 in 8,000	1 s	1 sa
1 in 10,000	0	1 sa
1 in 11,000	0	0
1 in 12,000	0	0

Water from the Calumet River and the Indiana Harbor Ship Canal flows into the lake at frequent intervals. These streams carry the combined waste of a number of industrial plants as well as domestic sewage for a fairly large population. As there are not many sewers emptying into the lake, it may be said that most of the objectionable waste products enter by way of these two streams. The tests on a sample collected where Canal Street crosses the Indiana Harbor Ship Canal show an odor threshold of 800 cold and 4,000 hot. The dilution required to find the odor threshold is considerably less than that for samples from the sewers of some of the industrial plants, although it is quite high for such a large volume of water.

EFFECT OF POLLUTION ON PUBLIC WATER SUPPLIES

Some idea of what occasionally happens on the South Side of Chicago may be had from Table IV, which gives the results of odor tests on raw lake water. These samples were collected at a time when conditions were severe, probably because the waste emptying into the lake became ponded under the ice until there was a considerable accumulation. Then it was released by the thawing of the ice, and a stiff wind drove it out into the lake to the water intakes.

TABLE IV. ODOR THRESHOLD DETERMINATIONS FROM SAMPLES OF RAW LAKE WATER

Location	Odor December 29, 1932 Cold (20 C)	Odor December 29, 1932 Hot (70 C)	Odor December 30, 1932 Cold (20 C)	Odor December 30, 1932 Hot (70 C)
East Chicago	11	250	200	700
Whiting	50	1,000	800	2,500
Hammond	41	250	11	26
Dunne Crib	2	11	2	9

Water having an odor threshold of 100 when hot is usually expensive to treat if the odor is to be removed completely, and when the odor threshold goes above 1,000, it may cost over $50 per million gallons more than the usual amount to produce palatable drinking water in a filtration plant. The filter plants at Whiting and East Chicago probably are not equipped for handling sufficient activated carbon to remove the odor. The amount of powdered carbon required when the odor threshold is over 1,000 very likely would be in excess of 1,000 lb per million gallons. No treatment except activated carbon has been found that will remove odors produced by oil refinery wastes. Although all the pollution shown in Table IV did not come from oil refineries, such plants contributed greatly to the trouble.

Planning for Planning

Principles for the Organization of State and Regional Planning on a National Scale

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IN addition to the planning of cities, counties, states, and interstate districts, there is need for a coordination of all the various planning bodies. It is suggested by Mr. Crane that there should be an agency of the Federal Government to bring together and unify all these individual efforts so that they will fit into a national program of development. He defines planning as the guidance of human activity toward a common well-being, and considers it a governmental function. As examples of governmental planning, he cites the Tennessee Valley project and the Nation-wide program for the control of crop planting by the Secretary of Agriculture. This article is an abstract of the paper presented by Mr. Crane before the City Planning Division on June 30, 1933, at the Annual Convention of the Society in Chicago.

ALMOST anywhere in America the word "planning" is now sufficient to arouse a responsive glow of enthusiasm even though its import and its implications may not be precisely understood. Nurtured by visionaries, the notion of planning for the future has suddenly become respectable and even popular. It is now proposed as a device for setting right all sorts of human ills. The supposition is that planning can be applied successfully to any single, detached community or national problem. To be effective, however, the increasingly numerous collective enterprises characterized as planning require integration, coordination, and orientation. The various facets of the public planning movement, as their interdependence becomes clear, will necessarily be drawn together into one cohesive, although many-armed organization, which will have its headquarters in Washington, and which will reach out into every geographical, political, economic, and educational unit in the United States. The organization may be quite loose as regards the formal relationship between its branches, but it must have cohesion for the sake of its work. It will be susceptible of diagramming on the basis of the rank of the agencies involved—Federal, regional, state, local; on the basis of its functional segments—manufacturing industry, agriculture, transport and social organization; on the basis of the social-economic and the physical structure; on the basis of living places, work places, and play places; and on the basis of economic welfare, safety, convenience, and the amenities of life. Into the elaborate mosaic will fit each phase of the activity which is beginning to be understood as planning, forming altogether a pattern and comprising an organization whose main purposes will be centrally controlled.

PLANNING BY GOVERNMENTAL AGENCY GUIDES COLLECTIVE HUMAN ACTIVITY

What is meant here by "planning?" It is the exercise of collective intelligence, expressed through government, to guide human activity toward the common well-being. It prevents the individual intelligence from going its own way. This collective intelligence is to be expressed through government and not through private compacts or group agreements—through government in its present rôle as the agency of the common will and in its new rôle as leader and planner. It is evident at once that this definition does not cover planning by the individual manufacturer for his own individual success, without regard to its broader implications. Nor does it cover joint planning by industrialists for their own advantage and that of their legions. Nor does it cover the project of a single county or state or region when the problem is conceived as purely local and is attacked on a purely local basis.

Successful railroad development must be planned in relation to other types of development far outside the field of the railroads. Agriculture must be planned in relation to industry, and conversely, for the security of both. Land planning in Illinois depends upon planned land utilization for the country as a whole. Chicago's metropolitan regional planning must finally be based on the planning of states and larger regional areas in such matters as the relocalization of industry and the migration of populations. Likewise, slum rehabilitation in Chicago or elsewhere can be accomplished in a rational and truly economical way only when the influence of larger factors and broader trends is known.

Planning then means the coordination of many types of activity under integrated local, state, regional, and Federal guidance or control.

It is not the making of fixed plans but the enterprise of guiding; it is an active, positive, continuing function. And as soon as planners undertake to guide street or building development or farm or waste-land utilization, they are led into the planning of the educational system, then the school fiscal system, then the entire tax system, and finally, the whole economic structure of the city, state, or commonwealth.

Some 1,200 American municipalities have town planning projects, each dealing in the main with a small area, a single political unit, and one phase of planning—that relating to physical development. Then there is metropolitan regional planning, which is in much the same category as city planning, except that it deals with the whole of an urban area, more or less regardless of political boundaries. An increasing number of counties have set up planning projects. State planning for physical development has already taken several forms. Wisconsin, Michigan, and Minnesota have gone in for state-wide planning of land uses; Iowa and New York for general conservation planning; California for state park planning; and Illinois for a wide range of planning. Further, here and there all over the country there are local and state plans for governmental reorganization, for tax revision, for educational systems, for highway and park programs, and for many other types of activity.

NATION-WIDE PLANNING BEGUN

Industrial planning on a national scale has already been begun in the guidance of commercial developments for the general welfare under the National Industrial

Recovery Act. Planning projects for flood control, reclamation, and conservation have definitely taken on a national character under governmental auspices. There also is a national landscape planning project on foot, to supplement the national park and state park movement. Finally, two other most significant planning operations are taking form in Washington. They illustrate two distinct methods of approach. One, the Tennessee Basin project, comprehends, according to the concept outlined by President Roosevelt, all the factors to be considered in planning, but in a limited area. The other, the many-sided agricultural and land-use planning movement, is Nation-wide in scope, but views the whole field from the angle of rural land use. In addition to skillful planning for that particular area, the Tennessee Valley Regional Plan requires coordination with organized interstate, state, and local planning agencies. It is equally important that it should be fitted into the national scheme through some governmental fact-finding and planning agency.

This is by no means a complete statement of the many points at which planning emerges and takes on importance these days, but an effort has been made to cite typical illustrations of the significant trends.

ORGANIZATION FOR PLANNING

In the matter of organization for planning, certain conclusions are inescapable. There are two controlling considerations. First, in planning for planning the organization of the work must anticipate general recognition of the principle that the physical structure, the social and political structure, and the economic structure are segments of one problem—interdependent, interpenetrating, to be dealt with as a whole. A plan for industry cannot be made without a plan for housing, or one for housing without an understanding of industrial trends. Plans cannot be made for agriculture without considering the social-political-economic structure which supports and is supported by it. The Tennessee Valley Regional Plan involves not alone planning for power and highways, but also, what is just as important, planning for education and for markets, to cite only two superficially distinct but essentially interrelated factors.

The second of the two controlling considerations in organizing for planning is the principle that no single geographic or political unit is self-sufficient or independent. The town, the county, the metropolitan region, the state, the larger region, the United States—each type of unit is for planning purposes dependent on the others in greater or less degree. Each has its own planning program; each may have its own planning agency, but always related to the others up and down the scale. I envisage, then, several types of planning committees and commissions—such as city planning, fiscal planning, and school planning—in each town, in each county, and in each metropolitan region; state boards in each state to coordinate the work of the local agencies and to deal with state-wide problems; a large-scale regional planning unit for each of the country's major regions, such as the Tennessee basin, to exercise over-all guidance of state and local work; and a group of Federal planning agencies set up in Washington that will bring all the regional, state, and local work into proper focus on a national scale.

President Roosevelt's Cabinet, with its advisers, is now acting as such a Federal, social, and economic council. Also the executive councils and the conservation and state planning commissions in certain states tend in this direction. While the administrative agencies must always find representation in the social and economic councils, they will also include other than purely administrative figures, and they will have their own staff personnel.

PLANNED GUIDANCE—A GOVERNMENT FUNCTION

There must be some line that can be drawn to maintain a satisfactory balance between the free action of the individual and the control of the government expressing the common will. It is of the utmost importance to find that line and hew to it.

* * * *

No individual, no trade group alone can achieve planned guidance. Government must take over the coordinating function.

EARLY ACTION NEEDED

Why should there be delay in accomplishing all this when action is required at once in the present emergency? With comprehensive planning it is to be expected that public works, slum rehabilitation and low-cost housing, land-use planning, the Tennessee redevelopment program, city and regional and governmental reorganization planning, will proceed better than has much of the work of this type in the past. However, it is here my aim to foresee the development of state, regional, and national planning in its larger, long-term relationships, and to envisage the plan for that planning so that each step may be more wisely made.

One example of such a comprehensive planning program now in operation is that in Russia. It has developed, however, on a basis quite different from ours. There the central purpose to which all else bears a subordinate relationship is that of building and rebuilding the whole structure of life on a definitely diagrammed socialistic or collectivistic basis. For orientation and cohesion, that approach has great advantages although it may involve back-tracking and consequent loss of headway. Here in this country whatever new concepts of social organization are adopted are being allowed to emerge and to take hold as the changing situation seems to demand. This has been described as the evolutionary, in contrast to the revolutionary, process. Thus far it has been the American method, and planning in this country reflects that method.

A GREAT OPPORTUNITY FOR EXERCISE OF INTELLIGENCE AND GOOD WILL

Plainly there is great significance in all this planning activity. It seeks to resolve the conflicts between individual and common interest, and between local and larger units. It seeks to obviate the wastes of too-hasty, planless development. It represents the transition from the period of occupation and exploitation of the country to the new period of readjustment, refinement, and balance. It tends to bring government to its full stature as the agent of the common will and the leader in the common enterprise. It offers the great opportunity for the exercise of collective intelligence and collective good will, an opportunity scarcely to be found in the planless society. It is a manifestation of what may be a new era of cultural, even spiritual maturity. And it is sought now as a means of staving off the defeat with which our human and humanitarian purposes are threatened. Chaos seemed ready to engulf us until the word "planning" was given a new magic and a new force by President Roosevelt and his colleagues. At the present time especially there is justification for making long-range plans for planning.

The Sewage-Treatment Problem at Duluth

Water Supply Endangered by Industrial and Domestic Wastes

By JOHN WILSON
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AT the western tip of Lake Superior, on opposite sides of the mouth of the St. Louis River, lie the cities of Duluth and Superior. Water for domestic purposes in Duluth is taken directly from Lake Superior at a point about eight miles from the mouth of the river, where the lake is 75 ft deep. Duluth-Superior Harbor in the mouth of the river, which is nearly landlocked by Park Point, is so polluted by industrial wastes and domestic sewage that it is impossible to use it as a source of domestic supply. Now, the discharge of the river into Lake Superior, together with the added domestic pollution from sewers discharging directly into the lake, threaten the safety of the lake intake of the water works. In a paper presented before the Sanitary Engineering Division of the Society on June 30, 1933, during the Annual Convention in Chicago, Mr. Wilson explained the problem confronting Duluth and the initial steps being taken to improve a situation which is fast becoming intolerable. This article is an abstract of the original paper.

WHILE the problem of sewage treatment always varies according to the locality, that of Duluth is probably modified to an unusual extent by local conditions and industries. The city is situated on the northwesterly shore of the St. Louis River and extends beyond the mouth of the river along Lake Superior for nearly ten miles. At some points the steep hillsides extending up to an elevation of 600 ft above the lake level are quite close to the water's edge, while at other points gentle slopes intervene.

The section of river abutting on the city is in fact but a detached part of Lake Superior, and except for the dredged channels is quite shallow, ranging from 5 to 8 ft in depth. These navigation channels are approximately 150 ft wide and from 17 to 22 ft deep. As shown in Fig. 1, the harbor has two openings through Park Point, the natural barrier which separates it from the lake. These openings are the Duluth Entry and the Superior Entry.

The total water surface of the harbor between Superior, Wis., on the southeast shore of the river, and Duluth, Minn., on the northwest shore, is about 13,000 acres. The main channel by way of the Duluth Entry is from 4 to 5 ft deeper than that leading to the Superior Entry and is also much shorter. The Duluth channel leading through Park Point is 300 ft wide and 30 ft deep, and the Superior channel, about six miles to the southeast, is 500 ft wide and 24 ft deep.

These conditions favor the discharge of the river through the Duluth Entry rather than through the Superior Entry. There is also evidence that the dredged channels which extend up the river where otherwise the water would be shallow, modify very much the manner in which the water finds its way to the lake. The river currents have a tendency to follow the dredged channels, leaving the water on the comparatively shallow flats more or less stationary. Ice to a thickness of 4 in. may accumulate over the greater part of the surface, but there is always open water in the navigation channels. The dredged channel extends up the river $6^1/_2$ miles from the Duluth Entry, to 58th Avenue West, although boats of shallow draft can go almost to the upper city limits near the Fond du Lac Dam.

The St. Louis River drains an area of 3,420 sq miles, the upper reaches of which receive the sewage from the Iron Range towns, or a combined population of 52,000. By the time the river reaches Cloquet, a city of 6,000 people situated 15 miles above Duluth, practically all evidence of this pollution has disappeared, although it may be one of the contributing causes to the decrease of fish life in the river.

To a considerable extent the flow of water in the river is governed by the operation of storage reservoirs, although the flood flow is at times very pronounced. The average daily discharge for the month of April 1927 was nearly 12,000 cu ft per sec; the average for the entire year was 2,500 cu ft per sec; and the minimum monthly average was 900 cu ft per sec.

At Cloquet, the river receives not only the sewage from a population of 6,000 but also the wastes from paper mills, amounting to about 15 mgd and having an oxygen demand equivalent to a population of about 80,000. Between Cloquet and the Fond du Lac Dam at the city limits, there are five water-power developments with a combined head of 575 ft, all controlled by the Minnesota Power and Light Company. Behind each of these dams there is a reservoir, back of which sludge is accumulating, including a considerable amount

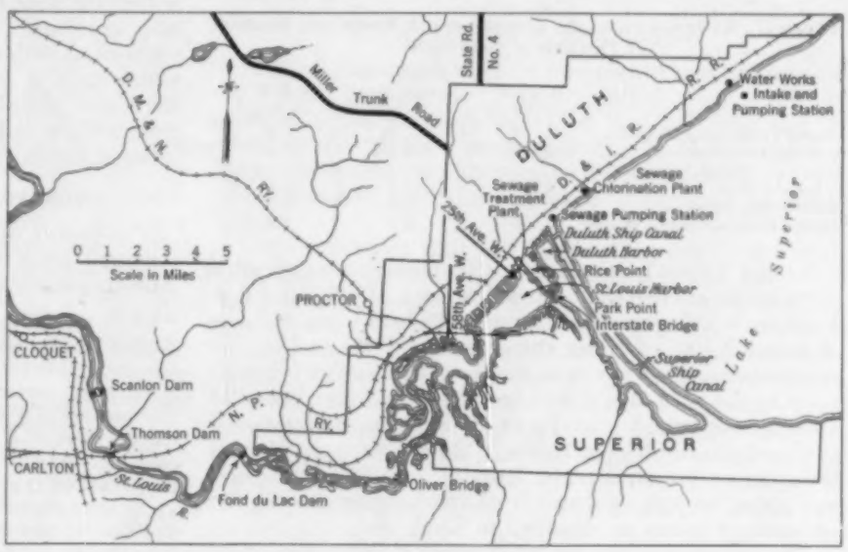

FIG. 1. LOCATION OF SEWAGE TREATMENT WORKS IN DULUTH, MINN.

of wood fiber as well as inorganic matter. Water wasting over the Fond du Lac Dam, the last of the five, releases a very strong odor of hydrogen sulfide and other odors peculiar to paper mill wastes. The fall of the river from Fond du Lac to the lake is very small—about $^1/_2$ in. to the mile, but at times more. Sometimes it even flows in the opposite direction, so that the lake water moves upstream.

Roughly, about 40 per cent of the sanitary sewage of Duluth is discharged without treatment into the river and harbor, and the remaining 60 per cent goes directly into the lake. All the sewage from Superior is disposed of in the river and harbor. There are no industrial wastes on the Wisconsin side, but Duluth has consider-

DULUTH ENTRY (UNDER LIFT SPAN) TO ST. LOUIS HARBOR
Sewage Pumping Station on Lake Shore at Left of Bridge. Superior Entry to the Harbor Through Spit in Dim Background

able amounts, the most important being those from the steel, coke, meat packing, and dairy industries. It should be noted that in the days when the lumber industry was at its height in this region, enormous quantities of sawmill wastes were deposited in the river and along the banks. Large areas of shallow water were reclaimed by filling in with slabs, logs, and sawdust. The sawdust seems to have spread over a large area of quiet water, and it still forms a part of the muck deposited on the bed. It probably exerts but little demand on the oxygen, although it no doubt has an important influence on fish and other aquatic life.

TABLE I. AVERAGE SANITARY CONDITIONS IN RIVER AND HARBOR AT DULUTH IN 1928–1929

STATION	B. COLI PER 100 CC	DISSOLVED OXYGEN IN PPM	B.O.D. IN PPM
One-half mile above Cloquet	58	7.3	2.3
Fond du Lac Dam	2,350	5.8	3.0
Interstate Bridge opposite 23d Avenue West	9,767	7.0	2.5
Duluth Ship Canal	86,500	9.4	3.5
Middle Duluth-Superior Harbor	2,610	6.9	2.4

In the Federal Census of 1930, Duluth was given a population of 101,463; Superior, one of 36,113; and Proctor, a village contributing to Duluth's sewers, one of about 2,400. During the season of 1928 and 1929 a comprehensive survey was made of the sanitary conditions in the St. Louis River, in which the State Board of Health cooperated. In Table I the average of some of the analytic results for 1929 are given, but a number of the stations are omitted for brevity. In 1928 the average 200-cc sample of water from the bottom showed the presence of fauna as classified in Table II.

The preponderance of mesasaprobic organisms indicates that decomposition was in the intermediate stage. The very small number of organisms of any kind at the Interstate Bridge reflected the toxic influences of the steel plant and coke ovens of the Interlake Iron Company. The largest number of organisms was found in the middle of the harbor, where the food supply is plentiful and the bottom erosion very small. According to

TABLE II. AVERAGE BOTTOM FAUNA IN 1928

LOCALITY	TYPE OF ORGANISM: POLY-SAPROBIC	MESA-SAPROBIC	OLIGO-SAPROBIC
Fond du Lac	34	289	11
Interstate Bridge	0	42	0
Duluth Ship Canal	5	4,666	1
Middle Duluth-Superior Harbor	0	6,083	0

Kolkwitz, the river and harbor would be classed as polluted—not septic but still too bad to be considered as merely contaminated.

LAKE POLLUTION ENDANGERS WATER SUPPLY

Duluth's water supply is taken from Lake Superior about eight miles from the Duluth Entry. The intake is located about 1,500 ft off shore in about 75 ft of water. The pollution problem of the lake is very different from that of the river. The principal sources of lake pollution are the river discharges through the two entries and about 60 per cent of the sanitary sewage of Duluth, distributed over a distance of about $5^1/_2$ miles.

At Park Point the width of the lake along the line of the two entries is about nine miles. Park Point forms the shorter side of a trapezoid, of which the longer parallel side, originating at the water works intake, is about 12 miles long. In general the line of maximum depth runs about two miles from the Minnesota shore and parallel to it, the depth gradually increasing from 25 ft to 180 ft.

As would be expected, the bottom fauna is most plentiful near the two entries to the harbor, and the organisms, such as the tubificidae, are generally found to decrease in number with increased distance from the canals, although at one point about six miles distant, from 300 to 600 sludge worms per square yard were found. The water secured at the intake is usually free from turbidity but shows very marked fluctuations in both temperature and bacteriological count. Occasionally the B. coli index is high. All these facts indicate that the intake is within the zone of contamination from the ever-changing lake currents. The problem of prime importance is, without question, the protection of the water supply, which now is secured by chlorination only. Possibly the most logical method of approaching the solution of this problem is to coordinate sewage treatment with additional facilities for water treatment.

CONCLUSIONS OF THE BOARD OF HEALTH

The report of the Minnesota State Board of Health, rendered after two years of investigation, contained the following statement:

> The investigation shows that a hazard exists from a public health standpoint, especially from Cloquet to the Duluth-Superior Harbor entrance to persons bathing and boating, or in any way coming in intimate contact with the river water or deposits of sludge. The analytical results indicate that it would not be practical to use the river as a source of domestic supply at any point in the above territory, as the river is polluted to such an extent that the pollution load is greater than should be carried by a modern water purification plant . . . . Appreciable quantities of oil, tarry wastes, and floating slag are evident on the west shore of Spirit Lake, St. Louis Bay, and Superior Bay. These are objectionable because they affect the appearance of the river and are detrimental to

fish and plant life. A condition of public nuisance also exists in various slips and around many sewer outlets discharging into St. Louis Bay, Superior Bay, and Lake Superior.

Spirit Lake, St. Louis Bay, and Superior Bay are but sections of what has been previously referred to as the St. Louis River between Fond du Lac and the Duluth Ship Canal.

In the "Statement of Requirements," the Board of Health's report further declared:

> It is the opinion of the Minnesota State Board of Health, the Commissioner of Game and Fish, the Wisconsin State Board of Health, and the Wisconsin Committee on Water Pollution that the pollution of the river and lake should be restricted to such an extent that the public health hazard will be reduced to a minimum; that the existing nuisances will be eliminated; and that the safety of the public water supply of the City of Duluth and the possible future supply of the City of Superior will not be jeopardized. The section of the river from the junction of the Swan River to Cloquet, and the section from Fond du Lac Dam to Oliver Bridge should be maintained in a condition suitable for fish life. The section from Oliver to Lake Superior should be maintained in such a condition that there will be no barrier to the migration of fish between Lake Superior and Oliver.

About five months of the year the St. Louis River is normally covered with ice. Several times samples of water have indicated that no dissolved oxygen was present. No one knows exactly how the water behaves under the ice cover. Neither is it known just how or when the lake currents change so that contaminated streams pass over the intake, or when drifting rafts of polluted water may approach it. There is such a multitude of interrelated influences, everchanging and recurring, the results of which manifest themselves first in one way and then in another, that no standard form of treatment or fixed course of procedure can be adopted to correct the situation.

TREATED SEWAGE TO BE DISCHARGED INTO THE HARBOR

Basically, the problem is to find some plan that will accomplish the desired results and not exceed the financial limitations of those who must pay the bills. An otherwise excellent plan is positively worthless unless sufficient funds are available to put it into effect. Public health officials are often heard to remark that they are interested in sanitary problems only and that financial questions are for others to decide. Such a policy not only will retard the work of improvement but may actually preclude the possibility of it. It has been urged in some quarters that the best is none too good, regardless of cost. But the problem of what constitutes the best is of no less magnitude than the main issue.

The plan finally approved by the Duluth City Council does not include any provision for treating industrial wastes, this matter being left to the industries themselves. It was decided to locate the plant on an abandoned sawmill site near 25th Avenue West, about three miles above the Duluth Ship Canal. Sewage from a population of about 14,000 will be treated in the unit now being constructed at 25th Avenue West. It consists of screens and facilities for grit removal, clarification, and chlorination. The sludge will be digested in separate tanks, and the gas will be used to heat the plant and burn the screenings. The intercepting sewers, pumps, and screening and chlorination plant at the lake shore, together with the plant at 25th Avenue West, will cost about $775,000 when completed.

According to the original plan, the first unit was to be a plant located about $6\frac{1}{2}$ miles from the pumping station and about $1\frac{1}{2}$ miles from the Duluth Entry, where sewage now entering the lake from a population of about 40,000 would be treated. At some future time another plant was to be constructed up the river at 25th Avenue West, where the present plant is now being built.

The principal advantages of the revised plan which was finally adopted are that eventually the sewage will be concentrated at possibly two plants instead of three; and that the effluent from the treatment plant will all go into the river instead of the lake, a condition that will tend to equalize variations in character of effluent and to increase the time interval required for the pollution to reach the water works intakes. The principal disadvantages are that, because of insufficient funds, the sewage now going into the lake will continue to do so. It will be passed through $\frac{1}{2}$-in. screens and chlorinated, but the efficiency of the latter process is subject to some doubt.

ST. LOUIS BAY, DULUTH, MINN.
Showing Location of Treatment Plant at 25th Avenue West Three Miles Up the River from the Duluth Entry to Harbor

As soon as funds are available to complete the plant at 25th Avenue West, the screening and chlorination plant now being constructed on the lake shore will be transformed into a pumping plant to force all the sewage to the plant at 25th Avenue West; but in the meantime the pollution along the sandy beach on the lake side of Park Point is increased. Also, the final cost of operation will be higher because of the additional pumping required and the possible necessity of providing secondary treatment for all the sewage rather than only for that flowing into the river.

A PROBLEM IN FINANCING

The relative value of these two plans is not as clear-cut as might be desired. Possibly either plan would be reasonably satisfactory provided that financial and industrial conditions were such that it could be carried to completion and that the city were in a position to apply the necessary remedies for such difficulties as might arise.

At the present time the intercepting sewers are being constructed and initial units installed in the hope that additional funds may be available to complete the program some time during the next five years. Little or no improvement in the condition of the river is contemplated at present. The results of misunderstanding, neglect, and indifference are likely to become very complex, and consequently remedies will be difficult to apply. It is hoped in time to meet the standards formulated by the various health departments, but for the present the city must be satisfied with the facilities now under construction, until more funds are available and public sentiment demands additional facilities and more complete treatment.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Volume Common to Two Intersecting Cylinders

By NORTON B. MOORE

RESEARCH FELLOW, CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIF.

SEVERAL times recently, in engineering design and construction problems, I have found it necessary to know exactly the common volume made by two intersecting cylinders, of unequal radii, whose axes are mutually perpendicular. Graphical integration of the elliptic integral involved, in addition to being laborious, is not satisfactory in a case where the radii are nearly equal. Nor is it satisfactory in a case where one radius is very small in comparison with the other. Although the exact solution is slightly difficult to obtain, it is very simple in form and results in a usable formula.

If the two cylinders are of equal radii, R, then every section of the common volume parallel to and at a distance x from, the plane of the axes, is a square of area $4(R^2 - x^2)$, and the common volume is

$$V_{RR} = 8\int_0^R (R^2 - x^2)dx = \left(\frac{16}{3}\right) R^3 \quad [1]$$

If the cylinders have radii r and R, where $0 \leq r \leq R$, then every such section is a rectangle of area $4\sqrt{(R^2 - x^2)(r^2 - x^2)}$, and the common volume is

$$V_{rR} = 8\int_0^r \sqrt{(R^2 - x^2)(r^2 - x^2)}dx \quad [2]$$

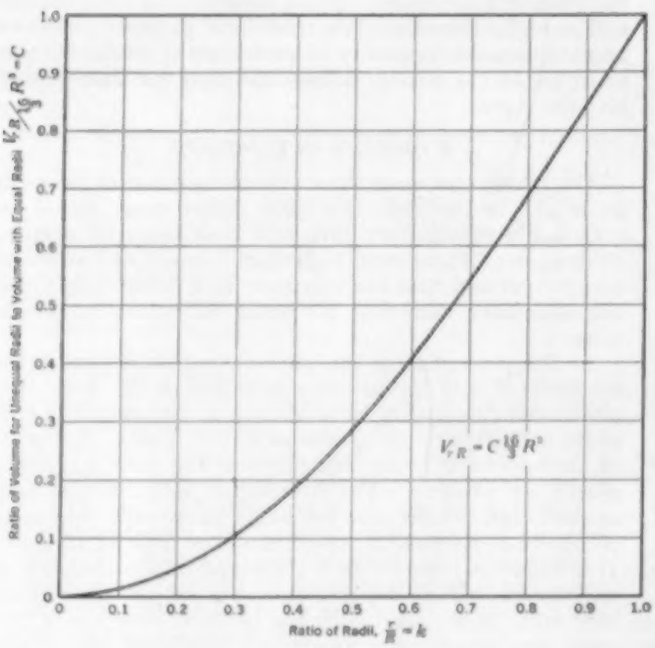

FIG. 1. CURVE OF THE COEFFICIENT C, FOR OBTAINING THE VOLUME OF INTERSECTING CYLINDERS OF UNEQUAL RADII

Dividing and multiplying the integrant by itself, and making the transformation, $x = r \sin \theta$, with $k = \frac{r}{R}$ it can be shown that

$$V_{rR} = 8k^2R^3I(k) \quad [3]$$

where

$$I(k) = \int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} - (1 + k^2) \int_0^{\frac{\pi}{2}} \frac{\sin^2 \theta \, d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} + k^2 \int_0^{\frac{\pi}{2}} \frac{\sin^4 \theta \, d\theta}{\sqrt{1 - k^2 \sin^2 \theta}}$$

Using the relations

$$\int_0^{\frac{\pi}{2}} \frac{\sin^4 \theta \, d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} = \frac{2}{3}\frac{(1 + k^2)}{k^2}\int_0^{\frac{\pi}{2}} \frac{\sin^2 \theta \, d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} - \frac{K}{(3k^2)}$$

$$\int_0^{\frac{\pi}{2}} \frac{\sin^2 \theta \, d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} = \frac{1}{k^2}(K - E),$$

$$\int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1 - k^2 \sin^2 \theta}} = K, \quad \int_0^{\frac{\pi}{2}} \sqrt{1 - k^2 \sin^2 \theta}\, d\theta = E,$$

to evaluate $I(k)$, the common volume is obtained as:

$$V_{rR} = \frac{8}{3} R^3 \left[(1 + k^2)E - (1 - k^2)K\right] \quad [4]$$

or

$$\frac{V_{rR}}{\left(\frac{16}{3}\right)R^3} = \frac{V_{rR}}{V_{RR}} = \frac{1}{2}\left[(1 + k^2)E - (1 - k^2)K\right] = C \quad [5]$$

or

$$V_{rR} = C\frac{16R^3}{3} \quad [6]$$

Values of E and K as functions of k are given in any table of complete elliptic integrals of first and second kind. In Fig. 1 are to be found the values of C, the ratio of the volume common to two cylinders of equal radii to the volume common to two cylinders whose radii are as r is to R.

As an example, the volume common to two intersecting cylinders 10 in. in diameter,

$$V_{RR} = \frac{16}{3} \times 5^3 = 666^2/_3 \text{ cu in.}$$

If one of the cylinders has a diameter of 8 in., the ratio $k = r/R = 0.8$. From Fig. 1, C equals 0.69 and

$$V_{rR} = 0.69 \times 666^2/_3 = 460 \text{ cu in.}$$

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Portal Effect on Bottom Chords

To the Editor: The article on "Portal Effect on Top-Chord Stresses," by B. J. Lambert, in the June issue, is very interesting.

It would, however, have added to the interest and completeness of his analysis if he had pointed out that, for a non-skew bridge with fixed shoes at one end and rockers or rollers at the other, the wind forces acting on the top chords cause a compression of $\frac{Pl}{K}$ in the windward bottom chord and an equal tension in the leeward bottom chord throughout their entire length. In this expression l equals the length of the end panel at the expansion end.

It would be interesting to apply this analysis to a skew bridge.

George L. Christy, M. Am. Soc. C.E.
Chief Engineer, Pittsburgh-Des Moines Steel Company

Pittsburgh, Pa.
July 20, 1933

Iron Truss Bridges in West Virginia

To the Editor: In the article, "Early Truss Bridges of Wood and Iron," in the July issue, Mr. Purdon discusses the Bollman iron truss and specifically mentions a bridge at Harpers Ferry, W.Va., on the Baltimore and Ohio Railroad, saying that it was the last one of this type to be abandoned.

The accompanying photograph that I made in May of this year shows an abandoned Bollman-type railroad bridge spanning a mill race about one-half mile west of Harpers Ferry. The main line of the Baltimore and Ohio Railroad is now located approximately 100 ft to the right.

Bollman-Type Railroad Bridge West of Harpers Ferry

A Bollman iron truss still serves as the western span of a highway toll bridge across the Potomac River at Harpers Ferry and has served in that capacity since 1894 when it was abandoned by the Baltimore and Ohio Railroad after three decades of railroad service on the main line. An interesting account of the Harpers Ferry bridges can be found in an article by P. C. Lang in *Engineering News-Record*, Vol. 107, No. 12, September 17, 1931.

H. K. Gidley, *Jun. Am. Soc. C.E.*
Assistant Engineer, Division of Sanitary Engineering, State Department of Health

Charleston, W.Va.
July 24, 1933

Erroneous Basis for Computing Tainter Gate Discharge

Dear Sir: In regard to Mr. Ripley's article, "Discharge Through Tainter Gate Openings," in the July issue, E. W. Lane, M. Am. Soc. C.E., has called the writer's attention to the fact that an erroneous basis has been used for the computation of Tables II and III. The data presented are valuable, and the errors in the method of analysis used by Mr. Ripley should be noted.

Textbooks on hydraulics have designated the center of the orifice for use in computing the head on the orifice. When the jet is discharging freely into the air and the ratio of the size of the opening to the head is very small, this is no doubt the proper head to be used in computation However, when the jet is supported and the vertical dimension of the opening is comparatively large, the distance from the headwater surface to the top of the opening is a more rational value to use as the head. At this elevation the surface of the moving water is first released to atmospheric pressure.

Author's Table I Recalculated. Pitot-Tube Readings for a Constant Head, H, of 9 Ft

Tainter Gate Opening No. 3 of the Dam at Fulton, N.Y. (Fig. 1)

Gate Travel on Rack In Ft	Vertical Distance Gate and Floor In Ft	Depth of Minimum Section In Ft	Average Velocity Heads In Ft	Average Velocity Minimum Section In Ft per Sec	Area of Minimum Section In Sq Ft	Discharge, Q, In Cu Ft per Sec
1	0.77	0.58	8.3	23.1	15.5	358
2	1.38	1.07	7.6	22.1	28.5	630
3	2.10	1.60	7.0	21.2	42.7	906
4	2.85	2.23	6.3	20.1	59.5	1,198
5	3.65	2.90	5.3	18.5	77.3	1,427
6	4.44	3.67	4.3	16.6	97.9	1,628
7	5.38	4.55	3.5	15.0	121.3	1,820
8	6.29	5.60	2.2	11.9	149.4	1,778

Author's Table II Recalculated from Table I for the Value of C

Gate Travel on Rack In Ft	Vertical Height of Gate Opening In Ft	Head Above Top of Opening In Ft	Ratio of Gate Opening to Head	Area of Opening, A, In Sq Ft	Discharge, $Q = AV$, In Cu Ft per Sec	Coefficient, C,* of Opening
1	0.77	8.23	0.089	20.53	472	0.758
2	1.38	7.62	0.166	36.80	815	0.773
3	2.10	6.90	0.264	56.00	1,180	0.768
4	2.85	6.15	0.377	76.00	1,511	0.792
5	3.65	5.35	0.509	97.33	1,806	0.790
6	4.46	4.54	0.659	110.93	2,033	0.801
7	5.38	3.62	0.853	143.46	2,189	0.831
8	6.29	2.71	1.094	167.73	2,214	0.803

* C is obtained by dividing Q, in the last column of Table I, by $Q = AV$ above. Theoretical V is given in Table III.

Author's Table III Revised. Theoretical and Actual Velocities Compared

Gate Opening In Ft	Theoretical Velocity $V = \sqrt{2gh}$*	Actual Velocity by Pitot Tube	Percentage of Actual to Theoretical
0.77	23.02	23.11	100.4
1.38	22.16	22.11	99.8
2.10	21.08	21.22	100.7
2.85	19.90	20.13	101.2
3.65	18.55	18.46	99.5
4.46	17.10	16.63	97.2
5.38	15.26	15.00	98.3
6.29	13.20	11.90	90.2

* h = H (9.00) minus gate opening.

Errors in computation, both large and small, have been found in Mr. Ripley's analysis. The writers are including Table I as cor-

rected and Tables II and III as revised according to the method of computing head suggested in the preceding paragraph. It should be noted that, in Table I of Mr. Ripley's article, at a rack travel of 7 ft, the computation of the discharge was in error by a considerable amount. The coefficient of discharge shown in our revised Table II varies from approximately 0.76 to 0.83. The trend of the coefficient, with varying ratio of gate opening to head, is in accordance with some unpublished experiments that have been examined by the writers. There is no reason why the coefficient should approach 0.62 as stated by Mr. Ripley, for the opening experimented with is contracted only at the top. The coefficient 0.62 is for an orifice in a thin plate.

The author has mentioned that, at the last reading, air was being carried under the gate. This would appear to be a stage of transition from a condition of orifice flow to one of flow over a broad-crested weir. According to the formula of Unwin and Frizell, for theoretical flow over a broad-crested weir, the depth below the drawdown should be two-thirds of the total head on the weir. At a rack travel of 8 ft, the vertical height of the opening is 6.29 ft, or a little more than two-thirds of the total head of 9 ft. This condition may account for the erratic values of the coefficient c and the percentage of actual to theoretical velocity.

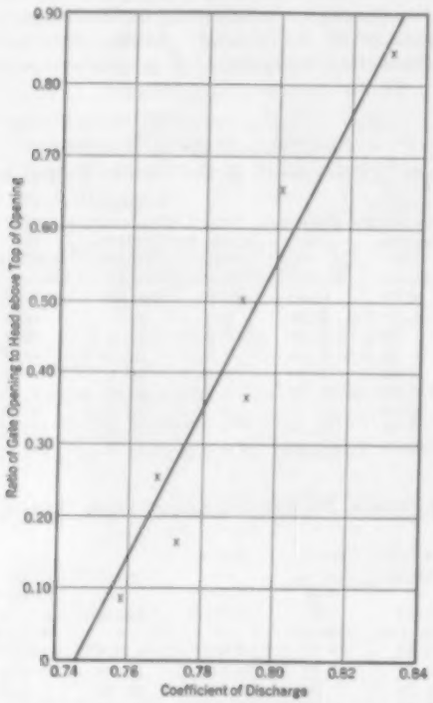

FIG. 1. DISCHARGE COEFFICIENTS OF FLOW UNDER TAINTER GATE AT FULTON DAM

A diagram of the coefficient of discharge as a function of the ratio of the gate opening to the head above the top of the opening is given in Fig. 1. Such a diagram has been found useful in hydraulic design. The questionable observation mentioned in the preceding paragraph has been omitted from the diagram.

F. B. CAMPBELL AND W. M. BORLAND, *Juniors Am. Soc. C.E.*
U.S. Bureau of Reclamation

Denver, Colo.
July 10, 1933

Wave Velocities in Rectangular Channels

TO THE EDITOR: I was interested in Professor King's article in the June issue. His Fig. 1 shows the water surface, after the passage of a wave, to be parallel to the original surface, and in the text he writes, "Between the wave and the gate each section has the same depth, D_2, and the same velocity, V_2, neglecting the modifying effects of friction and channel slope." Friction and channel slope may be neglected for the sake of an analysis of the mechanics of a wave front, but must be considered when studying the changes in regimen resulting from the presence of an increment wave. For instance, it requires a greater slope to carry sufficient water to "feed" the wave than to maintain the original flow, as a brief analysis will show. Professor King's Equation 2 may be rewritten as follows:

$$V_2 = V_1 + \frac{(D_2 - D_1)}{D_2}(v_w - V_1) \quad . \quad . \quad . \quad [1]$$

The wave speed in still water is $(v_w - V_1)$, and it is very nearly $\sqrt{gD_2}$.

If a wave 0.5 ft high is assumed to pass along a channel flowing 3.5 ft deep at a velocity of 3 ft per sec, then $V_2 = 3 + \left(\frac{0.5}{4.0}\right)(g\sqrt{4})$ = 4.42 ft per sec, or nearly 1½ times the original velocity. This ratio would be larger for a greater depth, a higher wave, or a lower original velocity. Referring now to the Chezy formula, $V = C\sqrt{RS}$, the factors C and R do not change appreciably for the wave just described, and hence the change in V must be accompanied by a greater change in S. Thus, the water surface slope must increase noticeably, which also means that the depth at any point that the wave front has passed will gradually increase. If the increased flow persists long enough, the depth will increase to a value at which the new flow can be conveyed at a slope equal to the original slope. The stage-discharge relation during this transition period of increasing slope is of course greatly altered, and any values taken from a simple rating curve will be in error.

It should especially be noted that Professor King's article demonstrates that the velocity of the wave front, relative to the moving water upon which it is superposed, is a function of only the initial and final depths. Practically, it suffices to consider it a function of the final depth alone, D_2. It should also be noted that his derivation is for a rectangular channel. For any other shape of channel, the effective depth, which is the area of cross section divided by the surface width, must be used.

JOHN B. DRISKO, *Jun. Am. Soc. C.E.*
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Cambridge, Mass.
August 9, 1933

Algebraic Method for Solving Torsional Stresses

TO THE EDITOR: An algebraic solution may be of interest for the tower subjected to torsion, which was solved graphically by Brent C. Jacob in the May issue.

Incidentally, the tower must be supported in a special manner to give the reactions assumed by Mr. Jacob. If each joint of the lower ring can take a vertical and a horizontal component of reaction, as is shown in the accompanying Fig. 1 (*a*), where the horizontal components are assumed fixed in definite directions by either slotted anchor-bolt holes or short links, the reaction components and bar stresses together total 26 unknowns. Each joint represents a system of concurrent non-coplanar forces in equilibrium and provides three equations. For a structure with eight joints it is possible, therefore, to write 24 equations and find 24 unknowns. Hence, the structure is indeterminate to the second degree.

The vertical components of reactions are caused by the tendency of the lower ring to warp. Two of these four equal components will act upward at diagonally opposite corners, and two downward at the other corners.

If the supporting forces at one corner are omitted, as in Fig. 1 (*b*), the structure becomes determined as regards both outer and inner forces combined (24 unknowns), and outer forces alone (6 unknowns), since a body in equilibrium in space acted upon by non-concurrent forces furnishes the following six equations: $\Sigma X = 0$, $\Sigma Y = 0$, $\Sigma Z = 0$, $\Sigma M_x = 0$, $\Sigma M_y = 0$, and $\Sigma M_z = 0$.

Considering Fig. 1 (*c*) as a free body it is seen, by use of equation $\Sigma Y = 0$, that $Y_6 = 0$. A moment equation with bar *o* as the axis shows that $V_5 = 0$, and another about *n* that $V_7 = 0$. Then, by $\Sigma V = 0$, $V_6 = 0$. A vertical axis through point 6 shows that

$$27X_5 + 26 \times 1{,}000 - 7 \times 1{,}000 = 0$$

$$\therefore X_5 = -\frac{19{,}000}{27} = -704$$

The minus sign indicates that X_5 acts to the left. The equation $\Sigma X = 0$ shows that $X_7 = 704$ acting to the right.

If joint 1 is taken as a free body, moments about bar *m* as an axis (*r* is parallel to *m* and therefore S_r has no moment about *m*, and S_d and S_e pass through the axis) show that $S_c = -1{,}000$. Taking joint 7 as a free body and *q* as an axis, $S_o = -704$. Similarly, $S_q = -1{,}000$ and $S_m = -704$. Each remaining joint has four unknowns, therefore let the stress in bar *t* be assumed as $+S$. Taking joint 2 as a free body and using bar *n* as an axis, it is seen that $X_u = -S$. $\therefore Y_u = \dfrac{-9}{19S}$.

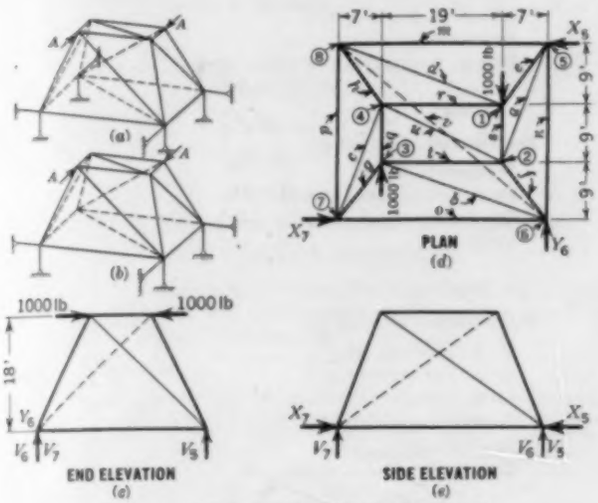

FIG. 1. DIMENSIONED CRANE SUPPORT
For Algebraic Solution of Stresses Produced by Torsion

At joint 3, using bar *n* as an axis and replacing S_g by its components at 7, give the equation:

$$18\,S_t - 33\,V_g = 0$$

$$\therefore V_g = \frac{+18}{33S}$$

Since no outer vertical forces act at any joint, it is seen that:

$$V_b = \frac{-18}{33S};\quad V_f = \frac{+18}{33S};\quad \text{and } V_a = \frac{-18}{33\,S}$$

Next,

$$Y_f = \frac{9}{18},\ V_f = \frac{9}{18}\left(\frac{+18}{33\,S}\right) = \frac{+9}{33\,S}$$

$$Y_a = \frac{18}{18},\ V_a = \frac{-18}{33\,S}$$

Use of the equation $\Sigma Y = 0$ at joint 2 now yields the value of *S*.

$$Y_u + Y_s + Y_a - Y_f = 0$$

$$+\left(\frac{-9}{19\,S}\right) + (-1{,}000) + \left(\frac{-18}{33\,S}\right) - \left(\frac{+9}{33\,S}\right) = 0$$

$$\therefore S = -773$$

As the components in a number of bars have been determined in terms of *S*, a large part of Table I can be filled in. By methods similar to those already used, the remaining components can be found. Last, the column "stresses" can be added.

TABLE I. COMPONENTS AND STRESSES IN TOWER
+ Tension, − Compression

BAR	PLUS OR MINUS	STRESS COMPONENTS V	X	Y	STRESSES
a	+	422	164	422	619
b	+	422	610	211	771
c	+	422	164	422	619
d	+	422	610	211	771
e	−	422	164	211	500
f	−	422	164	211	500
g	−	422	164	211	500
h	−	422	164	211	500
m	−	0	704	0	704
n	−	0	0	211	211
o	−	0	704	0	704
p	−	0	0	211	211
q	−	0	0	1,000	1,000
r	−	0	773	0	773
s	−	0	0	1,000	1,000
t	−	0	773	0	773
u	+	0	773	366	855
v	+	0	258	211	333

H. L. BOWMAN, M. Am. Soc. C.E.
Professor of Civil Engineering
Drexel Institute

Philadelphia, Pa.
June 28, 1933

Specifications for Early Subways

DEAR SIR: In his article in the August issue on "Modern Methods Used on Reclamation Projects," Dr. Elwood Mead makes the following statement in describing the methods of construction used by the U.S. Bureau of Reclamation:

"Thirty years ago nothing definite was specified as to the proportions of sand and gravel in concrete except that the engineer was required to make experiments to fix the proportions of cement and aggregates. Hand mixing was then in general use. In 1906 the first specifications appeared fixing the proportions of sand, gravel, and cement and requiring machine mixing."

In this connection it is of interest to note that, in the specifications prepared in 1899 for the construction of the first subway project in New York City, the following requirements for proportioning and mixing concrete were given:

"The proportions of mortar and stone used in making concrete shall be as follows:

"Concrete in arches of roof and sidewalls, where the thickness does not exceed 18 in.: 1 portion portland cement, 2 portions sand, 4 portions stone.

"Concrete in sidewalls or tunnel arches, where backing is rock in place: 1 portion portland cement, $2^1/_2$ portions sand, and 5 portions stone.

"Concrete in foundations in wet ground where thickness, exclusive of finishing floor concrete, exceeds 24 in.: 1 portion portland cement, $2^1/_2$ portions sand, 5 portions stone.

"Concrete in foundations where on rock, if not exceeding 12 in. in thickness: 1 portion portland cement, $2^1/_2$ portions sand, 5 portions broken stone. If exceeding 12 in.: 1 portion portland cement, 3 portions sand, 6 portions broken stone. [If the rock is dry, natural cement may be substituted for portland cement in this specification, but the amount of cement used must be increased by 30 per cent.]

"Concrete in mass, such as retaining walls, or backing of masonry retaining walls, in dry ground: 1 portion natural cement, $2^1/_2$ portions sand, 5 portions stone. If such retaining walls or backing are in wet ground, or subject to extraordinary strain, then portland cement shall be substituted for natural.

"The broken stone or gravel shall be spread on a platform sprinkled with water, and then thoroughly mixed with the mortar in the proportions as specified above. Machinery for the mixing of concrete may be used if approved by the engineer."

JAMES H. GRIFFIN, M. Am. Soc. C.E.
Engineer in Charge, Division of Contracts and Specifications
Board of Transportation

New York, N.Y.
August 7, 1933

SOCIETY AFFAIRS

Official and Semi-Official

First Ballot for Nominations Canvassed

REPORT OF TELLERS FOR 1934 SOCIETY OFFICES

BALLOTS, ON WHICH the members have indicated their first choice of members to fill the offices of Vice-Presidents and Directors which will become vacant in January 1934, were canvassed on August 1, 1933. This is the preliminary or "first ballot" from which the names of all who received 5 per cent or more of the total votes cast are normally to appear on the "second ballot." However, as usual, certain members have requested that their names be withdrawn from consideration on the second ballot.

The second ballot, which will be distributed shortly, is to be canvassed on October 16. The candidates receiving the highest number of votes on this ballot become the Official Nominees for the offices to be filled. The balloting for election of the Official Nominees, including the nominee for the office of President, to be selected by the Nominating Committee at the time of the next meeting of the Board of Direction, will take place in December and January, the results to be announced at the Annual Meeting in 1934.

For the information of members and for record, the report of the Tellers on the First Ballot follows:

New York, N.Y.
August 1, 1933

To the Secretary
American Society of Civil Engineers:

The Tellers appointed to canvass the First Ballot for Official Nominees report as follows:

Total number of ballots received	951
Deduct:	
Ballots from members in arrears of dues	143
Ballots without signature	5
Ballots with printed signature	1
Total withheld from canvass	149
Ballots canvassed	802

For Vice-President, Zone I

John P. Hogan	216
Charles M. Spofford	46
Ineligible candidate	33
Scattering	85
Void	3
Blank	6
Total	389

For Vice-President, Zone IV

H. D. Dewell	131
E. N. Noyes*	16
R. J. Reed*	16
F. C. Herrmann*	15
Ineligible candidate	26
Scattering	63
Blank	14
Total	281

For Directors, District 1 (Two to be elected)

O. H. Ammann	201
C. E. Trout	196
Ineligible candidates	32
Scattering	69
Blank	15
Total	263†

For Director, District 6

Thomas J. Wilkerson	39
Chas. M. Reppert	4
Ineligible candidate	7
Scattering	3
Total	53

For Director, District 2

Frank A. Barbour	26
Ineligible candidate	16
Scattering	15
Blank	16
Total	73

For Director, District 10

D. Hewitt Wood	38
Frederick H. McDonald	35
Scattering	5
Void	1
Total	79

For Director, District 13

T. E. Stanton Jr.	63
B. A. Etcheverry	15
G. A. Elliott*	8
Ineligible candidate	13
Scattering	12
Blank	1
Total	112

Respectfully submitted,

E. R. NEEDLES, *Chairman*

J. H. Granbery — Hiram Miller
A. W. Green, Jr. — Robert Stephenson
Jay D. Moore — V. R. Irvine
Edw. W. Ritchie

Tellers

* These members have requested that their names be withdrawn from consideration on the second ballot.

† Number of valid ballots cast, on most of which were two nominations for Director.

A Symposium on Water Hammer

DURING THE Sixty-Third Convention of the Society, a "Symposium on Water Hammer" was presented before a joint meeting of the Power Division of the Society and the Hydraulics Division of the American Society of Mechanical Engineers. For the past year and a half a committee of the American Society of Mechanical Engineers has been reviewing existing treatises and studying the experimental data available to confirm the various theories and formulas on water hammer. The report presented by the committee makes available to American engineers for the first time a comprehensive treatise on this subject.

The beginning of the present conceptions of surges was made by Michaud in 1878, but the classic experiments of Joukowsky in Moscow in 1897–1898, and the theoretical analysis of Allievi in 1903, can safely be called the basis of our modern theory. Until the work of these pioneers was made available in English, many approximate solutions were attempted and some unreliable formulas still persist. An elaborate structure, confirmed by experiment, has been built on the foundations laid by Michaud, Joukowsky, and Allievi. This permits the accurate solution of all problems, no matter how involved.

The papers contained in the symposium on water hammer have been privately published under the auspices of the Water Hammer Committee of the Hydraulics Division of the American Society of

Mechanical Engineers. To defray the cost of publication, a charge of $1 will be made to members of our Society, and copies may be obtained upon application to the publication sales department of the American Society of Mechanical Engineers, 29 West 39th Street, New York, N.Y.

Information Required for Loans to Private Corporations

EMERGENCY PUBLIC WORKS ADMINISTRATION ISSUES CIRCULAR NO. 3

In the applications of private corporations for loans under the National Industrial Recovery Act, the Public Works Administrator requires that certain information be furnished. The recently issued "Circular No. 3," which lists the requirements, is reprinted here to make the data available to all engineers interested in loans of this character.

FEDERAL EMERGENCY ADMINISTRATION OF PUBLIC WORKS

WASHINGTON, D.C.

August 10, 1933

CIRCULAR NO. 3

Information required with applications for loans to

PRIVATE CORPORATIONS

(OTHER THAN LOANS FOR HOUSING PROJECTS AND FOR PROJECTS FOR THE PROTECTION AND DEVELOPMENT OF FORESTS AND OTHER RENEWABLE NATURAL RESOURCES)

GENERAL INSTRUCTIONS

Four (4) complete copies of the application and the accompanying papers and drawings should be submitted to the State Advisory Board, Federal Emergency Administration of Public Works, whose office is situated in the State in which the project is located. If the project is located in two or more States, the application and other papers should be submitted to the State Advisory Board in the State in which the project principally lies.

All exhibits attached to the application should be given a convenient reference number.

The estimated costs required to be given should be based on the labor requirements and other special conditions set forth in the National Industrial Recovery Act, particularly section 206.

A study of the application may disclose the need for additional information. In order to expedite action on the application such information should be furnished promptly on request.

The application should state substantially the information called for below and in the order called for.

NOTE.—For the purposes, policies, functioning, and organization of the Emergency Administration and the rules prescribed by the President, see Circular No. 1, dated July 31, 1933.

II. SUMMARIZED GENERAL INFORMATION

(*a*) Exact corporate title of applicant, state of incorporation, specific statute under which incorporated, class of corporation (e.g., "public service corporation") as classified under the statute, and date of incorporation.

(*b*) Address of applicant.

(*c*) Name, title, and address of the official representative or representatives with whom correspondence should be conducted.

(*d*) Name and address of applicant's attorney.

(*e*) Name and address of applicant's consulting engineer or architect.

(*f*) Population of the municipality or community in which the project will be located for the years 1910, 1920, and 1930 (give brief explanation of any abnormal increase or decrease in population).

III. LOAN REQUESTED

(*a*) Amount.

(*b*) Security: State in detail the lien (e.g., first mortgage) offered as security, giving an adequate statement of the property to be subject to such lien.

(*c*) Period of the loan and maturities (annual amounts if serial maturities).

(*d*) Schedule showing dates when funds will be needed and amounts.

IV. THE PROJECT

(*a*) General description with drawings sufficient for a thorough understanding of the project; and report of consulting or other engineer or architect if available. If the project includes more than one of the types for which loans can be made to private corporations (e.g., a dock and market), the statement should show clearly what portion of the project constitutes each type. If a loan is sought for the construction of any incidental facilities, such incidental facilities should be described in detail, stating the need for the same, the capacity thereof and showing that they constitute an integral and indispensable part of the eligible project.

(*b*) Detailed estimate of the cost of the project subdivided into principal sections or items, in sufficient detail to permit checking, showing separately the following subtotals:

(1) Preliminary expenses;
(2) Cost of land, rights of way and easements;
(3) Construction cost, subdivided into principal structures or classes of work, and showing:
  (*i*) labor; and
  (*ii*) material cost for each subdivision.
(4) Engineering charges;
(5) Legal, administration, and other overhead charges;
(6) Interest during construction;
(7) Miscellaneous costs in reasonable detail.

(*c*) If the project is the improvement or extension of an existing system, set forth a complete description of the existing system.

(*d*) Statement of the economic and social value of the project.

(*e*) Statement as to whether or not project is part of a larger plan or long-range program of development; and if so, give description of other parts of plan or program.

(*f*) Statement as to whether or not the area served has a city or regional planning board, whether this project has been submitted to such board, and the views of such board, if any, in regard to it. (Report of planning board should be attached, if available.)

(*g*) Statement as to whether the community served is part of a metropolitan district and, if so, whether the project is coordinated with the plans for metropolitan development.

(*h*) Statement as to all endorsements that are known to have been made by civic groups and other similar bodies in respect of the project or the application, together with names and addresses of such endorsers.

(*i*) Statement as to all objections that are known to have been made in respect of the project or the application, together with the names and addresses of such objectors; if no such objections have been made, the fact should be stated.

(*j*) Statement as to whether or not the project will compete with any similar enterprise. If so, give name and address of owners or operators of the competing enterprises.

(*k*) Statement as to status of drawings and specifications; when construction can be commenced; and when project will be completed.

(*l*) Statement of estimated average number of men to be employed each month, directly on the project, giving the number of months.

V. REVENUE AND EXPENSES

(*a*) If project is an extension of an existing system, give statement with appropriate subdivisions showing for each of the past 3 fiscal years:

(1) Operating and other income;
(2) Operating and other costs.

Statement should also show for each such year, the extent of the business of the system, as indicated by number of consumers or users, quantity of production or sales or other similar data.

(*b*) Give estimate with supporting data of annual operating and other income and of operating and other costs reasonably to be anticipated from the project if a new system, or from the existing system as extended or improved by the project, for the life of the loan. Give estimate showing for each year the extent of the business of the system as completed or as enlarged and extended, based upon the estimated number of consumers or users, quantity of production or sale or other similar data, appropriately classified.

(*c*) State application of estimated income and disposition of surplus for each year during the life of the loan.

(*d*) Discuss any unusual conditions affecting present or estimated future operating and nonoperating income and expenses.

(*e*) Give schedule of rates now in force and proposed rates after completion of the project, stating whether such rates are subject to approval by State, county, or municipal authority and, if so, status of such approval. If approval has been obtained submit certified copy of documents containing such approval.

VI. FINANCIAL DATA

Brief history of the applicant (including its predecessors, if any) and business, including a review of past operations and a statement of the general character of business now transacted, with a detailed statement of the manner of conducting the business.

(*b*) Capitalization, stating the essential details of each class of stock, including:

(1) Designation;
(2) Par value;
(3) Number of shares authorized;
(4) Number of shares outstanding;
(5) Dates issued;
(6) Consideration received for outstanding shares and, if other than cash, a specific description thereof, together with a statement of the basis of valuation and the present value thereof;
(7) Preferences as to dividends, liquidation, etc.;
(8) Voting rights.

(*c*) Funded indebtedness, with essential details of each issue including:

(1) Class of indebtedness and designation;
(2) Authorized indebtedness;
(3) Date of issue;
(4) Maturity;
(5) Interest rate;
(6) Consideration received and, if other than cash, specific description thereof, basis of valuation and present value thereof;
(7) Security;
(8) Miscellaneous provisions (redemption, conversion, etc.).

(*d*) Statements corresponding to those required under sections (*b*) and (*c*), as to any capital stock or funded indebtedness (including the proposed loan) to be issued in connection with the carrying out of the project.

(*e*) Financial statements:

(1) State the dates of the beginning and ending of the fiscal year (present or proposed, as the case may be);
(2) Balance sheets as of the latest available date (in any event within 3 months) and as at the end of each of the preceding 3 fiscal years;
(3) Profit and loss statements for each of the preceding 3 fiscal years;
(4) Analysis of surplus account for each of the preceding 3 fiscal years;
(5) Pro forma balance sheet reflecting the proposed loan and any other financing in connection with the project and showing the acquisition of any properties to be acquired in connection therewith (and showing the basis of valuation thereof).

These financial statements should be accompanied by sufficient explanatory data to show clearly the present financial condition of the applicant and its financial condition after the carrying out of the project, and to justify the book value of assets as shown on any said balance sheets.

(*f*) A statement showing application of estimated income and disposition of surplus for each year during the life of the loan, including:

(1) Estimated operating expenses;
(2) Interest on proposed loan;
(3) Principal payments on proposed loan;
(4) Sinking fund on proposed loan;
(5) Interest, principal, and sinking-fund payments on any other indebtedness;
(6) Other nonoperating expenses;
(7) Preferred stock dividends;
(8) Balance available for other corporate purposes.

(*g*) Officers and directors:

(1) Name and address of each director;
(2) Name and address of each officer;
(3) Statement of the amount of stock and/or bonds, notes, or other obligations of the applicant owned by each officer and director, and of any indebtedness of any such officer or director to the corporation;
(4) Compensation, including salary, bonus, fees, and any other emoluments received from the applicant by each officer and director.

(*h*) If 30 per cent or more of the common stock of the applicant is owned or controlled by another corporation or affiliated corporations, data in respect of such controlling corporation or affiliated corporations corresponding to the information set forth in sections (*b*) to (*e*), inclusive, and in section (*g*).

VII. LEGAL DATA

(*a*) The following documents should be included in the application:

(1) Certificate of incorporation, with all amendments, certified by the Secretary of State (or other appropriate officer) of the State of incorporation. This should include (where required) articles of association or agreement, certificate and all pertinent documents, any agreements of merger or consolidation, etc., necessary to show clearly the complete organization of the applicant;
(2) In case the applicant was organized by special statute, a duly certified copy of the statute and all amendments thereto and of any applicable provisions of general statutes, and any amendments adopted pursuant to general statute;
(3) Copy of the by-laws of the applicant, with all amendments to date, certified by the secretary or assistant secretary of the applicant under its corporate seal;
(4) Copy of resolutions of the board of directors and stockholders (if necessary) authorizing the making of the loan application.

(*b*) A legal memorandum covering fully the following matters:

(1) Formalities in connection with the organization or standing of the applicant, including particularly any necessary consents of public service commissions or other State, municipal, or other public bodies and a short statement of annual or franchise tax reports to be filed by it;
(2) The corporate power of the applicant to enter into and construct the project and to incur and secure the proposed indebtedness. The memorandum should include appropriate citations from the articles of incorporation and any applicable statutes;
(3) The legal proceedings, formalities, and corporate action required in connection with the construction or operation of the project, including:

(*i*) Permits or franchises from Federal, State, or local public bodies, for such construction or operation, with appropriate citations of statutory provisions concerning the granting of such franchises or approvals. There should be included a statement of any legislative authority necessary in connection with such construction or operation;

(*ii*) Approval by State board of health of the plans and specifications for water system, etc.;

(*iii*) Approval of rates by public service commission or other appropriate body;

(*iv*) Grants of lands or of easements or other rights in lands by public bodies, citing statutory provisions and judicial decisions concerning the authority of such bodies to make such grants;

(*v*) Present status of such authorizations, approvals, grants, etc., and a full statement of the proceedings necessary to secure the same, estimating the time necessary for completing such proceedings.

(4) Legal proceedings, formalities and corporate action taken and to be taken by the applicant in connection with the proposed loan, including the following:

(*i*) Action by board of directors;

(*ii*) Necessity of stockholders' consent and how such consent may be given;

(*iii*) Necessity of consent of public service commission or other public body, and proceedings necessary for securing such consent;

(*iv*) Legal limitations as to amount of indebtedness, interest rate, and sales price of securities;

(*v*) Power of applicant to mortgage the property to be covered by the lien securing the loan. Particular attention should be paid to mortgaging franchises, property granted by public bodies, and other rights in which the public might have an interest.

(5) Acquisition of property by the applicant, including:

(*i*) Right of eminent domain or condemnation and proceedings for exercise of the same;

(*ii*) Acquisition of land or rights therein from private persons, including statement as to any disability of such grantors or other complication in connection with the transfer;

(*iii*) Acquisition of property from public authorities and power of such authorities to transfer the same. Discuss fully questions arising in connection with property (such as land under water) held "in trust for the public," etc.;

(*iv*) Statement of what property has been acquired and what property is to be acquired.

(6) Statutory or other provisions for the recapture or other acquisition of the project or any part thereof, by Federal, State, municipal, or other public authority.
(7) A full statement as to any litigation in process, pending or threatened, which might in any way affect the project, the proposed loan, the security therefor, or the financial condition of the applicant; if there is no such litigation, so state.
(8) A brief description of the terms of all existing and proposed contracts, leases, and other agreements with respect to the project or the financing, construction, operation, maintenance, or use thereof. Certified copies of all such agreements should be attached to the loan application as exhibits.
(9) If the applicant is a parent or subsidiary corporation or is affiliated with any others, a full statement of any special circumstances arising out of such relation which might affect the proposed project, the proposed loan, the security therefor, or the financial condition of the applicant, together with all other relevant information with respect to the intercorporate relations.
(10) The eligibility of the applicant and the project for a loan under the National Industrial Recovery Act, showing under what specific section the loan is sought, what specific type of eligible project is proposed and showing clearly that the project comes under one of the authorized classes specified in said act, or the Emergency Relief and Construction Act of 1932. The memorandum should discuss the actual application of the proceeds of the loan, showing that such proceeds are to be expended for eligible purposes and whether any portions of the project or of any related plan or program are without the scope of the Act, or are considered eligible as being incidental to an eligible project.

(NOTE.—The memorandum should cite all constitutional provisions, statutes, ordinances, regulations, charter or by-law provisions, etc., applicable to the project, or the financing, construction, or operation thereof, or the revenues to be derived therefrom, or the proposed loan or the security therefor, and any franchises, approvals, permits, licenses, etc., obtained from Federal, State, municipal, or other public authorities, and any proceedings taken by the applicant with respect to the project or its financing. Copies of all such constitutional or statutory provisions and other documents, or applicable portions thereof, should be attached to the memorandum.)

(*c*) An opinion of counsel for the applicant to the effect that:

(1) The applicant is a corporation duly organized and existing and in good standing under the laws of the state of incorporation (specifying the same) with an authorized capital stock as stated in such opinion.
(2) The outstanding stock (stating the number of shares, par value, and classes so outstanding) of the applicant has been duly and validly issued and is validly outstanding (stating whether the same is full paid and nonassessable).
(3) The applicant has full corporate power and authority to construct and operate the project.
(4) There are no legal obstacles which would prevent or unreasonably delay the carrying out of the project, the creating of the indebtedness, the issuing of evidences thereof, or the giving of security therefor.
(5) The loan application has been duly executed on behalf of the applicant by its duly authorized officer or officers.
(6) The proposed evidences of indebtedness will, upon issuance, be valid and binding obligations of the applicant in accordance with their terms, secured as set forth in the application.
(7) The proposed obligations are (or are not) legal investments for administrators, trustees, and other fiduciaries, and for savings banks and insurance companies organized under the laws of the State or States in which the project is situated.

[THERE IS NO FEE FOR FILING AN APPLICATION.]

A Preview of Proceedings

The September issue of PROCEEDINGS *is to contain an unusual variety of papers, covering several phases of professional work, such as dam design, highway economics, the legal functions of the surveyor, photo-elastic methods of stress analysis, and duration curves for the study of problems connected with stream flow.*

STABILITY OF STRAIGHT GRAVITY DAMS

A NICE BLENDING of the practical with the theoretical characterizes the paper by D. C. Henny, M. Am. Soc. C.E., who advocates the abandonment of the middle-third theory and a sliding factor in designing masonry dams, and develops the theory that the safety of a straight masonry dam is due mostly to its shearing strength. The influence of uplift, percolation, and the pressure of water in the void spaces of water and concrete is discussed. By means of numerical examples at the end of the paper, the new theories are demonstrated in a very practical way.

An acknowledged expert in the design and construction of dams, Mr. Henny has long been intensely interested in this particular phase of the subject, namely, the physical aspects of uplift and the true values of safety factors in dams. At the request of the Society's Committee on Irrigation Hydraulics, he spoke before the meeting of the Irrigation and Power Divisions on July 7, 1932, when the Society held its Convention at Yellowstone National Park. Subsequently a very brief abstract of Mr. Henny's paper was published in the September 1932 issue of CIVIL ENGINEERING. The present paper was developed from this previous one, with sundry changes, corrections, and additions, including a discussion of the research work in this field done by S. H. Woodard, M. Am. Soc. C.E.

AMBURSEN DAM RECENTLY COMPLETED FOR CITY OF PRESCOTT, ARIZ.
Height 76 Ft; Length 500 Ft

ESTIMATING THE ECONOMIC VALUE OF PROPOSED HIGHWAY EXPENDITURES

A METHOD of determining whether a required expenditure for improving a given highway is economically justifiable is presented in the September PROCEEDINGS in an authoritative paper by Thomas R. Agg, M. Am. Soc. C.E. Professor Agg's paper is so brief and compact that no adequate preview could be given without publishing the paper itself.

A brief restatement of the fundamental theories forms the starting point, as expressed by the relation, "highway transportation costs = highway costs + vehicle costs." Three types of highway improvement projects are analyzed in this manner: first, improvement by building a road surface of a higher type; second, improvement by relocating the route so as to shorten the distance between terminals; and third, improvement that will reduce the rates of grade with or without a change in distance.

THE SURVEYOR AND HIS LEGAL EQUIPMENT

IN A PAPER defining such basic legal concepts as the order of calls, marks of boundaries, the doctrine of adverse possession, the doctrine of acquiescence, and riparian boundaries, A. H. Holt, M. Am. Soc. C.E., has opened for discussion a subject of outstanding importance.

Although this is a brief paper, it is well arranged and should serve as a useful reference to clarify the legal functions of a surveyor in the establishment of boundaries. The cardinal principle of the law of boundaries is stated as follows: "A boundary line, having once been authoritatively—even though inaccurately, or erroneously—fixed in position on the ground, the true purpose of a resurvey is to reproduce that location." Mr. Holt, a member of the bar of the State of Iowa, is particularly well fitted to defend his views on this subject.

PHOTO-ELASTIC ANALYSIS OF STRESSES IN COMPOSITE MATERIALS

IN AN UNUSUAL paper on a somewhat unusual subject, A. H. Beyer, M. Am. Soc. C.E., and A. G. Solakian, Assoc. M. Am. Soc. C.E., give the stress analysis, by photo-elastic methods, for a few simple models of transparent bakelite reinforced with aluminum rods. The elastic properties of this composite material, used for the first time at Columbia University, approximate those of concrete when reinforced with steel rods.

The internal stresses that are set up in the bakelite and in the aluminum rod, as a result of the cooling after casting, are also stated to be a qualitative index of the shrinkage stresses set up in a concrete member when reinforced with steel. Both the internal stress distribution resulting from the fabrication of the models and that resulting from applied load have been analyzed for the simpler cases. The results that have been obtained are very instructive and indicate that, when due allowance is made for the shrinkage stresses and the tensile strength of the bakelite, the net stress resulting from the applied load alone, when determined by photo-elastic methods, checks quite closely the theoretical stress determined in accordance with accepted standards.

The phenomena of the double refraction and the subsequent interference of rays of polarized light, when passed through a stressed isotropic transparent material such as glass, were first described by E. Bartholin in 1669. Not until 1813 did Seebeck, Brewster, Wertheim, Neumann, Carus Wilson, and others apply this method to determine the stress distribution developed under applied loads in transparent materials. During the first quarter of the twentieth century, Mesnager, Coker, Favre, and many others studied and perfected the optical method of stress analysis in transparent materials.

In the United States, Nickerson as early as 1872, Marston in 1893, and more recently, the Research Laboratories of the General Electric Company, the Westinghouse Electric and Manufacturing Company, the Massachusetts Institute of Technology, the University of Michigan, and Columbia University have made further important contributions to stress analysis by optical methods—a branch of science that is now generally known as photo-elasticity.

The stress patterns obtained from a transparent model by photo-elastic methods disclose the intensities of the principal shear stresses for co-planar stress distributions. Under the polarized white light the zones of equal principal shear stresses are indicated by yellow, red, and green bands repeated in the same order over and over again as the stress intensity is increased. Under polarized monochromatic light the same zones appear in black and white and are somewhat better defined. In the case of pure tension or pure compression such as obtain in pure bending, the tensile and compressive stresses can be directly evaluated from these bands, for in pure tension or compression the stress is directly proportional to the maximum principal shear stress. For the more complicated co-planar stress distributions, additional optical or physical measurements must be made before the principal stresses can be evaluated.

WATER BEARING MEMBERS FOR ARTICULATED BUTTRESS DAMS

MANY OF the advances in articulated buttress dams relate to improved types of water-bearing members. The recent trend toward

the use of wide buttress spacings has made the correct proportioning of these water-bearing members of major economic importance. To properly proportion the decks and haunches of the articulated buttress dam is a long and tedious task that has heretofore been accomplished only by trial computations.

In this paper H. D. Birke, Assoc. M. Am. Soc. C.E., has developed a scientific method of obtaining such results directly without the long intermediate computations that heretofore have been necessary. While the mathematical developments of Mr. Birke's paper may be considered formidable, it is pointed out in the conclusions that the final simplified equations and curves are easily applied to actual design problems.

The results of Mr. Birke's paper cover the entire range of articulated buttress dam design from the standard Ambursen type with close buttress spacing, as shown in the illustration of the Prescott Dam, to the massive buttress type with wide spacing, and to the round-head type.

DURATION CURVES

ENGINEERS have long been accustomed to the use of graphical methods of study. In hydraulic work, particularly, the hydrograph and mass curve are well known tools for the analysis of statistics of stream flow. Within the past fifteen years a new graphical method, the duration curve, has come into quite general use. This method has many decided advantages, but its use requires a proper understanding of the basic properties. The paper by H. Alden Foster, M. Am. Soc. C.E., contains a detailed description of this method, explains the basic principles involved, and shows the relation of the duration curve to other graphical methods. This paper fills a gap in engineering literature, as no complete discussion of the duration curve method has heretofore been available. No mathematics other than arithmetic are involved, in this presentation, which lays emphasis on fundamentals and on practical applications. In addition, certain features of the method are here published for the first time. The paper is easy to read and should be found useful by both the student and the experienced engineer.

Using Another's Data Without Permission or Credit

BOARD OF DIRECTORS CONDEMNS A BREACH OF ETHICS

TEMPORARILY Engineer A gave employment to Engineer B in his laboratory in order that Engineer B might become familiar with certain testing methods for the purpose of professional experience and advancement. After a few months on routine work without material contributions to the major program of the laboratory, B resigned. Engineer A permitted him to retain certain data and diagrams resulting from the work of other investigators, in consideration of his agreeing not to publish any results, even of his own work.

Subsequently B submitted a paper to a foreign engineering periodical, which was published, using his borrowed diagrams and data, failing to give credit for their origin, and leaving the inference that B himself had carried out the work. Engineer A asked for a ruling on the ethics of such action and for proper discipline.

The veracity of the allegations having been substantiated, the Board of Direction decided that: (1) Engineer B is guilty of a breach of the spirit of the code of ethics; and (2) the stealing of credit for research work done by others is most reprehensible.

Engineer B's resignation from the Society was accepted.

Arthur Powell Davis, Past-President 1861–1933

NEWS COMES from Oakland, Calif., of the death on August 7 of Arthur Powell Davis, Past-President of the Society. This will be a shock to Mr. Davis' many friends, scattered all over the country. He was best known for his work and efforts on behalf of national reclamation. Having been connected with the Reclamation Service from its inception, he was made Chief Engineer and finally Director. His removal from this office in 1923 assumed the importance of a national scandal and was the subject of official condemnation by this Society and many other engineering organizations.

Subsequently Mr. Davis was active in irrigation and water projects in the Far West and, from 1929 to 1931, was consulting engineer for the Soviet Government in Turkestan and Transcaucasia. Some of the results of his interesting stay in this Asiatic country were reported in his fascinating paper on "Irrigation in Turkestan" in the January 1932 number of CIVIL ENGINEERING. A month before he died he was appointed consulting engineer for the Boulder Dam project, of which he was an early, if not the original, sponsor.

In the Society, Mr. Davis gave generously of his interest and time. He served on boards and committees and was a frequent contributor to publications. From 1917 to 1919 he was a Director of the Society, and in 1920, during a most difficult period of post-War readjustment, he was President.

Because of his wide acquaintanceship in Government and private engineering circles both on the Atlantic and Pacific coasts, his death will be widely mourned. Burial took place at Washington, D.C., on August 14. The Society will take steps to secure a fitting memoir for publication in TRANSACTIONS.

New Memoirs Now Ready

ALTHOUGH MEMOIRS of deceased members of the Society are published annually in TRANSACTIONS, they are made available in pamphlet form prior to their appearance in that publication. This practice is a convenience for the friends and family of the deceased. A new group of memoirs has now been printed and is available for distribution to interested members on request. The list of these follows:

Frederick Wilhelm Albert
Christian Andersen
Con Morrison Buck
Harry Burgess
Armand John Calleri
Harry Ezra Cameron
Branch Harris Colby
Herbert Chapin Daggett
Louis Christian Datz
Arthur John Ela
Francis Feher
David Pryde Gilmore
Everett Addison Hadley
Morris Knowles
Sidney Francis Lewis
John William Link
John Robert Clarke Macredie
Rollo Glenroy Manning
Cyril Ernest Davis Marshall
Arthur Pomeroy Melton
Lester Louis Meyer
Lee Haun Miller
William Nelson Page
John Augustus Roebling
Albert Owen Rowse
John Egon Skafte
Frank Woodward Skinner
Francis Pitt Smith
Philip Henry Ward
Philip Ridsdale Warren
Paul Revere Williamson

Some of the difficulties encountered in obtaining the data on which to base the memoirs may be realized when it is noted that the memoir of an engineer as well known as John Augustus Roebling, who died in 1869, has just now been published by the Society.

Appointment of Society Representatives

ALONZO J. HAMMOND, President Am. Soc. C.E., and JOHN P. HOGAN, HARRISON P. EDDY, MALCOLM PIRNIE, and JOSEPH JACOBS, Members Am. Soc. C.E., who constitute the Society's present Committee on Public Works, have been appointed to serve as Society representatives on a Joint Committee with the American Institute of Architects to study the question of a Department of Public Works.

News of Local Sections

DAYTON SECTION

There were 18 in attendance at the regular meeting of the Dayton Section held at the Engineers Club at noon on June 19. After a luncheon, Leslie M. Abbe, a local engineer, gave a talk on the subject, "The First Homestead Unit in Dayton."

GEORGIA SECTION

On July 10 the Georgia Section held a luncheon meeting at the Atlanta Athletic Club in Atlanta. The speaker of the occasion was Robert Ramspeck, member of Congress from Georgia, who discussed the topic, "The Work of the Extra Session."

PHILADELPHIA SECTION

A Philadelphia improvements inspection trip, dinner, and meeting were enjoyed by the Philadelphia Section on May 18. The attendance at these events was 127, 90, and 105, respectively. Five construction projects were visited in the course of the afternoon. These were the new Franklin Institute Building, Fairmount Dam, the Belmont Filter Plant, the Pennsylvania Station, and the new U.S. Post Office Building. The projects visited on this inspection trip were described in interesting addresses presented as part of the program for the evening. Among those who spoke were the following: Frank N. Kneas, Chief Engineer for John T. Windrim; Charles E. Bonine, Associate Director of the Franklin Institute; H. S. Loomis, assistant to the general manager of the Union Switch and Signal Company; and John H. Rankin, of Rankin and Kellogg. Several of these addresses were illustrated by motion picture slides. During the course of the evening, prizes were awarded in the Section's annual competition for the best papers on selected engineering subjects by senior members of Student Chapters in District 4.

PORTLAND (ORE.) SECTION

A meeting of the Portland (Ore.) Section was held in the club room of the Portland Chamber of Commerce on May 11. The entertainment provided for the occasion consisted of an illustrated lecture by Homer M. Hadley, Regional Structural Engineer for the Portland Cement Association, who described the recent earthquakes in southern California of which he was an eye-witness. By means of motion pictures he described the effect of the earthquakes on different types of structures. The attendance numbered 29 members and 36 guests.

SAN DIEGO SECTION

The annual "Ladies Night" of the San Diego Section was celebrated by a dinner meeting at the Churchill Hotel on May 25. G. H. Macumber, of the United Air Lines, gave an entertaining and instructive talk on commercial aviation, illustrating his remarks with a motion picture entitled "Across the United States in Twenty-Seven Hours."

The regular monthly dinner meeting of the San Diego Section was held on July 27 at the Churchill Hotel. Former mayor, John L. Bacon, a mechanical engineer, outlined the provisions of the National Industrial Recovery Act and led the lively and extended discussion that followed.

SYRACUSE SECTION

At the annual meeting of the Syracuse Section, held on May 15 at the University Club, officers for the ensuing year were elected as follows: Henry G. Throop, President; Edward F. Berry, First Vice-President; Victor J. Milkowski, Second Vice-President; Francis D. McKeon, Secretary-Treasurer; and Sergei N. Grimm, Director. There were 34 present, including 9 members of the Syracuse University Student Chapter.

TEXAS SECTION

The spring meeting of the Texas Section was held at the Buccaneer Hotel in Galveston on May 5 and 6, with 100 members present. One session was devoted to a consideration of business affairs, and one whole day was given over to the presentation of interesting papers on timely engineering subjects. Included among the speakers were the following: R. E. Fristoe, Chief Engineer of the Galveston Wharf Company; J. Russell Wait, Port Director of Houston, Tex.; and E. P. Cowley, Superintendent of the Gulf, Colorado and Santa Fe Railway Company. During the business session, E. N. Noyes, a Director of the Society, discussed current Society activities. On the last afternoon of the meeting the group were guests of the Galveston Chamber of Commerce for a boat trip on Galveston Harbor.

Student Chapter News

ALABAMA POLYTECHNIC INSTITUTE

In the course of the past year the Alabama Polytechnic Institute Student Chapter held several interesting meetings. Upon these occasions the students heard talks on various current engineering topics. These were given by members of the faculty and the Chapter. Also, a lecture on map making was presented by Thomas B. Chambers, Resident Engineer for Robert L. Totten, Inc., of Auburn, Ala.

BUCKNELL UNIVERSITY

Several illustrated lectures furnished by the Society were enjoyed by the Bucknell University Student Chapter during the year. Upon other occasions the members were addressed by fellow students and by members of the faculty. In January a trip was made to New York City for the purpose of attending the Annual Meeting of the Society.

COOPER UNION

The Cooper Union Student Chapter reports an attendance of 400 at the five meetings held during the past year. Upon these occasions the members were privileged to hear such well known engineers as R. L. Williamson, of the Aluminum Company of America; Ole Singstad, Chief Consulting Engineer on Tunnels for the Port of New York Authority; and Gilbert D. Fish, a consulting engineer of New York, N.Y. On May 16 a business and social meeting was held at the Dixie Hotel in New York, and on May 27 a visit of inspection was made to the Brooklyn Bridge.

DREXEL INSTITUTE

The Drexel Institute Student Chapter has enjoyed several contacts with the Philadelphia Section of the Society during the past year, including an inspection trip to various Philadelphia improvements recently completed. In the prize competition conducted by the Philadelphia Section for the best Student Chapter papers, the Chapter won two of the three prizes offered and two of three honorable mentions. The Chapter also sent a delegation to attend the Fall Meeting of the Society, held at Atlantic City early in October. In January it gave a Materials Testing Laboratory demonstration during the Drexel "Open House," and in April sponsored a Civil Engineers' Night. Altogether, 15 meetings were held by the Chapter.

DUKE UNIVERSITY

On April 27 and 28, the Duke University Student Chapter, in conjunction with the student chapter of the American Institute of Electrical Engineers and the Duke University Society of Mechanical Engineers, sponsored an "Engineering Open House." There were over 900 present at this event. During the past year the Chapter has held four regular meetings, with a total attendance of 89. These were addressed by student members. On other occasions motion pictures were shown.

GEORGE WASHINGTON UNIVERSITY

There were eight meetings held by the George Washington University Student Chapter during the past year, with a total attendance of 112. These were addressed by various faculty members of the engineering department of the university, whose subjects ranged from battleship construction to the Florida hurricane of 1928. In January an Engineers' Ball was given.

GEORGIA SCHOOL OF TECHNOLOGY

Numerous educational and social activities have engaged the Georgia School of Technology Student Chapter during the past school year. These activities have included illustrated lectures, inspection trips, motion pictures, and the annual informal dance held every year to further engineering and social contacts. On May 1 the Chapter met with the Georgia Section of the Society. An unusual number of meetings have been held, and these have been widely attended. Included among the speakers were Moses E. Cox, of the Georgia State Highway Department, and J. H. Johnston, consulting engineer for the Georgia Public Service Commission.

HARVARD ENGINEERING SOCIETY

The past school year has been one of notable activity for the Harvard Engineering Society Student Chapter. In all, 15 meetings were held, with a total attendance of 486. Early in May Lazarus White, President of Spencer, White and Prentis, Inc., of New York, N.Y., gave a series of illustrated lectures on the application of new theories of earth pressures as applied to the design of foundations and underpinning work. Two major meetings were held, to which all the members of the university were invited. One of these meetings was addressed by L. J. Johnson, Professor of Civil Engineering at Harvard University; the other by Allston Dana, Engineer of Design for the Port of New York Authority. Perhaps the most outstanding event of the year was a six-day excursion to New York City, which took place early in April and included an inspection of all the major engineering projects between Cambridge and New York.

NEWARK COLLEGE OF ENGINEERING

The annual report of the Newark College of Engineering Student Chapter indicates that the past year has been one of interest and activity for the membership. In October a trip was made to the Newark Air Port and the Port of Newark; and in April, 38 members of the chapter attended a meeting of the Metropolitan Section held in New York, N.Y. At the meetings, a wide range of engineering subjects was discussed by such well known engineers as M. R. Sherrerd, Chief Engineer of the New Jersey State Water Policy Commission, and Chester Mueller, Principal Assistant Engineer of the Newark Department of Public Affairs. Motion pictures of current construction projects were shown at some of the meetings.

NORTH DAKOTA STATE COLLEGE

During the fall semester the North Dakota State College Student Chapter held three of its meetings in conjunction with the other professional societies in the engineering school of the university. At the other meetings held during the year, illustrated lectures, supplied by the Society, and speakers furnished the entertainment. In all, there were nine meetings and an attendance of 211.

OHIO NORTHERN UNIVERSITY

Semi-monthly meetings of the Ohio Northern University Student Chapter have been held during the past year. These events have been very well attended, and various faculty and student members have given lectures on timely engineering subjects. Outside speakers were M. H. Hendriks, District Engineer of the Ohio Paving Brick Association; R. H. Randall, President and Chief Engineer of R. H. Randall and Company, of Toledo, Ohio; and L. H. Gardner, of the Ohio Corrugated Culvert Company, of Cleveland.

OHIO STATE UNIVERSITY

The annual report of the Ohio State University Student Chapter states that the members enjoyed six dinner meetings during the year. Among the engineers who spoke on these occasions were the following: J. R. Burkey, Chief Engineer of Bridges, Ohio State Highway Department; B. M. Brock, of the Carnegie Steel Company; and Robert Hoffmann, of the Department of Public Works of the City of Cleveland. On May 9, 1933, the Chapter had the honor of entertaining Alonzo J. Hammond, President of the Society, who discussed the subject, "The Federal Works Program." There were approximately 100 present at this meeting, the largest attendance of the year.

TUFTS COLLEGE

Illustrated lectures on engineering subjects of current interest have been enjoyed by the Tufts College Student Chapter during the school year just completed. These were presented by members of the Chapter and the faculty. In all, four meetings were held, with a total attendance of 117.

UNION COLLEGE

All of the meetings held by the Union College Student Chapter during the past school year were addressed by outside speakers. These sessions have attracted unusually large audiences. David C. Coyle, consulting engineer of New York, N.Y.; Frank P. McKibben, consulting engineer of Black Gap, Pa.; S. D. Sarason, Professor of Civil Engineering at Syracuse University; and Andrew Vogel, Engineer in Charge of the Plant Engineering Department of the General Electric Company, were prominent on the list of speakers.

UNIVERSITY OF AKRON

The March meeting of the University of Akron Student Chapter was a joint session with the local student branch of the American Society of Mechanical Engineers. The speaker of the occasion was Ralph Cole, President of the Canton Malleable Iron Company, of Canton, Ohio, who gave an interesting illustrated address on the subject of malleable iron. The Chapter held several other interesting meetings in the course of the past school year.

UNIVERSITY OF ARIZONA

During the recently completed school year the University of Arizona Student Chapter has held ten meetings, at which there was a total attendance of 270. Motion pictures on the manufacture of steel, arc welding, riveting, and construction work on Boulder Dam were shown at some of these meetings. At others interesting speakers were heard on a variety of engineering subjects.

UNIVERSITY OF ARKANSAS

A series of student lectures on Boulder Dam was enjoyed by members of the University of Arkansas Student Chapter at meetings held during the fall semester. Other timely engineering topics were discussed by members of the Chapter and faculty at subsequent meetings, and motion pictures were shown upon some occasions. Informal smokers also attracted several enthusiastic gatherings. Two trips were made to the Veterans' Hospital at Fayetteville for a general inspection of construction, and during the week of May 28 to June 3 the members were in Chicago, inspecting the engineering features of the World's Fair.

UNIVERSITY OF CALIFORNIA

Various interesting speakers addressed the meetings of the University of California Student Chapter held during the past semester. Included among these were the following: Fred C. Scobey, Senior Irrigation Engineer in the U.S. Department of Agriculture, Berkeley, Calif.; R. E. Davis, Professor of Civil Engineering at the University of California; and B. M. Woods, Professor of Mechanical Engineering at the university.

UNIVERSITY OF CINCINNATI

On May 3 the University of Cincinnati Student Chapter was invited by the Cincinnati Section of the Society to a dinner meeting, at which the guest of honor was Alonzo J. Hammond, President of the Society. President Hammond spoke on the value of Society membership. Among the speakers at other meetings held by the Chapter during the year were H. D. Loring, of the Ferro Construction Company, of Cincinnati, and Professor Von Schlichten, of the geology department at the university.

UNIVERSITY OF FLORIDA

Discussion of numerous engineering subjects and the showing of lantern slides, furnished by the Society, occupied most of the sessions held by the University of Florida Student Chapter in the past school year. These meetings were addressed by several members of the faculty as well as by members of the Chapter. In October a special meeting was held for the purpose of welcoming the freshmen and explaining to them the advantages of membership in the Chapter.

UNIVERSITY OF IDAHO

Regular monthly meetings have been held by the University of Idaho Student Chapter during the past school year. Among those whom the membership has been privileged to hear upon such occasions are the following: Ivan C. Crawford, Dean of the College of Engineering of the University of Idaho; H. T. Evans, District Engineer, Department of Public Works, State of Idaho; and Joseph A. Murphy, Resident Bridge Engineer in the same department.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for October

ACTUATED BY a desire to improve its traffic facilities and at the same time to create public works for the relief of the unemployed, the City of Richmond, Va., has borrowed money from the Reconstruction Finance Corporation to build several bridges. These are to be operated as toll bridges until the loan is amortized. In an article to appear in the October issue, S. C. Jemian, Assoc. M. Am. Soc. C.E., describes the bridges under construction and the reasons for the adoption of the design of each. The article is of double interest: first, as a practical example of the application of public works in creating jobs for idle men; and second, for a description of the unique features incorporated in the design of these reinforced concrete bridges.

On the morning of May 6, 1932, the cry of "Fire" brought the fire-fighting facilities of the City of New York to the Chelsea Pier of the Cunard Line in the Hudson River at 13th Street. Before the fire was extinguished three days later, the pier had burned to the water line and required complete rebuilding except for the foundation piles. How the tangled mass of concrete and structural steel superstructure, and the pump, piping, and boilers were cleared away and a new pier erected on the old wooden piles in record time is told in an article by R. T. Betts, M. Am. Soc. C.E. The pier was rebuilt in eight months at a cost of $837,000, and the *Aquitania* made the first regular docking at the new pier on January 10, 1933.

Water for irrigation in Southern California is perhaps more efficiently used and produces greater returns for the expenditure involved than in any other part of the United States. The combination of fertile soil and scarcity of water makes this true. Early Californians, dependent upon surface run-off, suffered severely from droughts, and steps were taken to augment the scanty rainfall by the development of springs and artesian wells. Large and continuous overdrafts on the underground supply have dried up the springs, and nearly all the artesian wells have long ceased to flow. In a paper on the "Cost and Value of Water in Southern California," Franklin Thomas, M. Am. Soc. C.E., traces the history of the development of water sources for irrigation and domestic consumption and compares the rising costs in this section of the country with those in other parts of the United States.

In studying some shear phenomena in loaded soil masses, Dimitri P. Krynine, M. Am. Soc. C.E., has used methods similar to those adopted by Dr. A. Nadai in his experiments on metals, except that moist soils formed the experimental material. Professor Krynine's tests convince him that, while a natural soil mass does not act as an elastic body, it may acquire elastic properties under heavy pressure. The results of his recent tests and conclusions will appear in the October issue of CIVIL ENGINEERING.

The characteristics of the hydraulic jump as phenomena of running water are usually determined for unit widths of wide channels. For restricted channels of other than rectangular cross section the solutions are more complicated. In an article on "The Hydraulic Jump in Standard Conduits," J. C. Stevens, M. Am. Soc. C.E., presents formulas for the height of the jump in triangular, trapezoidal, parabolic, and circular conduits. Methods for determining the energy losses in the jump for each form of conduit are also given.

Photo-elasticity as a means of analyzing stresses in structural members is being revived after decades of disuse. Since engineers are now using the method quite generally, it seems appropriate to publish an article that will enable those less familiar with the method to correctly interpret the meaning of the contour-like bands of light which appear in photo-elastic pictures. Such an article has been written for the October CIVIL ENGINEERING by Thomas H. Evans, Jun. Am. Soc. C.E.

The Relation of the Founder Societies to the Library

Address Delivered at a Joint Meeting of the Founder Societies and the United Engineering Trustees Boards in Chicago on June 27, 1933

By H. P. CHARLESWORTH
PRESIDENT, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE ENGINEERING Societies Library is one of the most important cooperative activities of the four national societies of civil, mining, mechanical, and electrical engineers. As a composite, thoroughly indexed, and conveniently arranged library, developed from the individual libraries of these four societies, it is well prepared to serve effectively in virtually the entire field of engineering.

Each society, in the development of its technical publications, has constantly endeavored to supply to its members the most desirable technical material originating in its own division of engineering, and has thus enabled them to keep in close touch with technical progress of the types in which they are especially interested. No society can, however, hope to supply all the technical material, even in its own division, which its members desire. By their cooperative support and development of a single library of large proportions, the engineering societies have made readily accessible to their members the world's best engineering books and periodicals, and the cost to each society has been moderate.

The thousands of members of the societies who are able to visit the library find a reading-room service of high type, which assists them in locating quickly the specific information desired, and adequate, comfortable quarters in which to do their reading. The appreciation with which these opportunities are regarded is shown by the number of readers recorded in 1932, 32,882, an increase of 17 per cent over the number for 1931.

The service bureau is prepared to study information in written form, such as photostats, reports on searches, and translations. Thus it meets the needs of many members, regardless of their location, who do not have access to a good engineering library or who do not find it convenient to do their own library work. Although it is necessary to charge for the major items of work done by the bureau, it also answers many inquiries for specific bits of information for which no charge can be made. The service bureau is especially helpful to the staffs of the Founder Societies in answering many inquiries for various types of information which they refer to the library. Thus it renders a very important service to the society members and saves the time of staff members who otherwise would find it necessary to search for the desired information.

The book-lending service of the library enables members located anywhere to borrow virtually any current American engineering book at a charge of five cents per day plus transportation charges.

In 1932, 70 searches and 138 translations were made; 24,675 photoprints were supplied to 3,041 persons; 250 books were borrowed by 207 persons; letters were written to 3,519 members; and 7,830 items were added to the permanent book collection.

This brief outline emphasizes the importance of maintaining the joint facilities now offered by the library and of further acquainting the members of the societies who are unable to visit it, with the services which can be secured by mail. The possibilities of this type of service have been only partially realized. It is hoped that the four societies and The Engineering Foundation will be able to maintain the library on a basis at least equivalent to the present, and that as soon as conditions permit, its services will be expanded in such directions as will be most beneficial to the members of the societies.

Another Degree Conferred

IN THE JULY and August issues of CIVIL ENGINEERING were published items listing the members of the Society who had recently been awarded honorary degrees. Since these lists were published, information concerning another member similarly honored has reached Society Headquarters, as follows:

EDWARD H. ROCKWELL, M. Am. Soc. C.E., Doctor of Engineering, Worcester Polytechnic Institute.

NEWS OF ENGINEERS

From Correspondence and Society Files

CHARLES SEGER, until recently irrigation engineer of the J. G. White Engineering Corporation, Don Martin Project, Camaron, N.L., Mexico, is now connected with the Middle Rio Grande Conservancy District, New Mexico, as resident engineer on the El Vado Dam.

FERRAND S. MERRILL, formerly assistant to the division engineer of the American Bridge Company, has been made assistant division engineer.

EDWARD P. BABCOCK has opened offices in Ridgefield, Ill., as a consulting engineer. He was formerly principal assistant engineer for I. F. Stern of Chicago, Ill.

A. F. JOHNSON has taken a position with the U.S. Bureau of Public Roads in Detroit, Ore.

G. DONALD KENNEDY has become connected with the Michigan State Highway Department, with headquarters in Lansing, Mich.

PHILIP C. NASH, who for the past four years has been executive director of the League of Nations Association, has resigned that post and accepted the presidency of the University of Toledo, at Toledo, Ohio.

A. C. LEE has become associated with the W. S. Lee Engineering Corporation in Charlotte, N.C.

LE ROY O. HINES, who has been county engineer of Princess Anne County, with headquarters at Princess Anne, Va., is now resident engineer of the Virginia State Department of Highways, at Halifax, Va.

C. Z. OVERSTREET has become associated with the São Paulo Tramway Light and Power Company, of São Paulo, Brazil.

R. M. MERRIMAN is now connected with the Metropolitan Water District of Southern California, with headquarters at Indio, Calif.

ROBERT W. ABBETT has resigned his position as instructor of civil engineering at the Sheffield Scientific School, Yale University, to accept an appointment as Assistant Professor of Building Construction on the Thompson-Starrett Foundation at Union College, Schenectady, N.Y.

HERBERT KENNETH MURNER is now working for the Six Companies Inc., on Boulder Dam, Boulder City, Nev.

ELMER A. BENDER has returned to the employ of the Vang Construction Company of Pittsburgh on the new Allegheny River Lock No. 3.

JOSEPH SORKIN has been promoted from Bridge Draftsman to Bridge Designer in the Department of Public Works of Nebraska, at Lincoln, Nebr.

JOEL D. JUSTIN, formerly Hydroelectric Engineer of the United Gas Improvement Company, has opened an office for the practice of his profession at 246 South Fifteenth Street, Philadelphia, Pa.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From July 10 to August 9, 1933, Inclusive

ADDITIONS TO MEMBERSHIP

ANGELL, LESTER WILLIAM (Jun. '33), Three Mile Bay, N.Y.

ATKINS, ROBERT BOYER (Jun. '33), Asst. Constr. Engr., Aronberg-Fried Co. (Res., 219 Eleventh St., S.W.), Washington, D.C.

ATKINSON, GEORGE LEE (Jun. '32), With State Highway Dept. (Res., 1908 Wolfe St.), Little Rock, Ark.

BARKSDALE, HENRY COMPTON (Assoc. M. '33), Asst. Engr., State of New Jersey, New Jersey State Water Policy Comm., 714 Trenton Trust Co. Bldg., Trenton, N.J.

BEACHAM, JACK GARLINGTON (Assoc. M., '33), City Engr. and Supt. of Water Works, Box 522, Athens, Ga.

BROWN, EDGAR GREGSON (Assoc. M. '33), Junior Engr., U.S. Engr. Office, War Dept., Care, U.S. Army Engrs., 410 Old Customhouse, Detroit, Mich.

BROWNELL, EDWARD FULLER (Assoc. M. '33), Asst. Engr., U.S. Engr. Office, St. Paul, Minn.

CLARK, EDWARD SHANNON (Jun. '33), County Highway Surv., Otsego County, East Worcester, N.Y.

COOPER, FRANKLIN DIXON (Jun. '33), 3732 West 46th St., Cleveland, Ohio.

CRUMLISH, HUGH JOSEPH (Assoc. M. '33), Constr. Engr., Western State Penitentiary, Bellefonte (Res., Pleasant Gap), Pa.

DOUGLASS, ARDEN HEMAN (M. '33), Mgr., Water Dept. and Supt., Sewage Disposal, Wichita Falls, Tex.

ELLIS, ALBERT RALPH (M. '33), Vice-Pres., Pittsburgh Testing Laboratory, 1330 Locust St., Pittsburgh, Pa.

FRIEDLANDER, MORTIMER ALTMAN (Jun. '32), 535 Parkside Ave., Brooklyn, N.Y.

HAINES, DORSEY DONALD (Assoc. M. '33), Instr., Dept. of Civ. Eng., Univ. of Kansas (Res., 2042 New Hampshire St.), Lawrence, Kans.

HILL, GEORGE MITCHELL (Assoc. M. '33), Gen. Mgr., Parker Machine Works (Res., 4367 Central Ave.), Riverside, Calif.

HILL, WILLIAM CRAWFORD (Jun. '32), 3436 Fifth Ave., South, Minneapolis, Minn.

HOLLSTROM, GUNNAR EUGENE (Jun. '33), Instr., Civ. Eng., Worcester Poly. Inst., Worcester, Mass.

KAVANAGH, THOMAS CHRISTIAN (Jun. '33), 181 East 104th St., New York, N.Y.

KETTLE, KENATH AUSTIN (Jun. '33), Superv. Engr., South Charleston Constr. Div., Carbide & Carbon Chemicals Corporation (Res., 2112 Kanawha St.), Charleston, W.Va.

LESLIE, JAMES BOOTH, JR. (Jun. '33), Junior Engr., U.S. Waterways Experiment Station (Res., 927 Bowmar Ave.), Vicksburg, Miss.

MACGREGOR, ROSS EDWARD (Assoc. M. '33), 46 Primrose Ave., Floral Park, N.Y.

MCINNES, JOHN PAXTON (Assoc. M.'33), Instrumentman, Office of City Engr. (Res., 730 South St.), Toledo, Ohio.

MAZZOLA, LOUIS (Assoc. M.'33), 1624 Seventy-eighth St., Brooklyn, N.Y.

MONONOBE, NAGAHO (M. '33), Director, Experiment Station of Public Works, Home Dept., Japanese Govt.; Prof., Civ. Eng. Dept., Tokyo-Imperial Univ. Naimusho-Dobokushikensho, Hongo-ku, Komagome, Tokyo, Japan.

PIPER, CLAYTON LEROY (Assoc. M. '33), Engr., City of Toledo (Res., 4526 Eastway), Toledo, Ohio.

RIDENOUR, CLYDE OTMER (Jun. '33), With Columbia Eng. and Management Corporation (Res., 2771 Shaffer Ave.), Cincinnati, Ohio.

ROBERTS, WALTER FRIEDGEN (Jun. '32), 2063 North Meridian St., Indianapolis, Ind.

RUMSEY, RICHARD MORDEN (Assoc. M. '33), County Supt. of Highways, Niagara County, Court House, Lockport (Res., 9311 Buffalo Ave., Niagara Falls), N.Y.

SANDERS, WILLIAM LEANDER, JR. (Jun. '33), Junior Engr., Met. Water Dist. of Southern California, Banning, Calif.

SCHROEDER, WALTER NICHOLAS (M. '33), Asst. Bridge Engr., State Highway Dept. (Res. 2129 South 5th St.), Springfield, Ill.

STEUBER, WILLIAM FLOYD (Jun. '33), Res. Engr., State Highway Comm., Div. 5 (Res., 217 North 8th St.), La Crosse, Wis.

STILSON, ALDEN EARL (Assoc. M. '33), Chf. Engr., Morse Boulger Destructor Co., 205 East 42d St., New York (Res., 7141 Juno St., Forest Hills), N.Y.

SYKES, ROY JAMES (Jun. '33), 1500 South St. Francis, Wichita, Kans.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1933

Members	5,795
Associate Members	6,322
Corporate Members	12,117
Honorary Members	18
Juniors	2,964
Affiliates	113
Fellows	5
Total	15,217

TETAR, CLYDE WILLIAM (Jun. '33), 1059 New York Ave., Brooklyn, N.Y.

URIBE RESTREPO, FEDERICO (Jun. '33), Bugalagrande, Valle, Colombia.

WHEELER, JOHN WARD (M. '33), Member, State Highway Comm., State House Annex, Indianapolis, Ind.

WORKMAN, LEWIS JACOB (Jun., '33), Junior Engr., U.S. Bureau of Reclamation, Denver, Colo.

MEMBERSHIP TRANSFERS

BARNES, GEORGE ERIC (Jun. '23; Assoc. M. '28; M. '33), Head, Dept. of Civ. Eng., and Prof., Hydr. and San. Eng., Case School of Applied Science, Cleveland, Ohio.

BEALOFF, HERMAN MATTHEW (Assoc. M. '26, M. '33), Vice-Pres., Brader Constr. Corporation, 551 Fifth Ave., New York (Res., 4515 Twelfth Ave., Brooklyn), N.Y.

BROWN, CHANNING BOLTON (Jun. '23; Assoc. M. '24; M. '33), Structural Engr., Duke Power Co. (Res., 1324 Berkeley Ave.), Charlotte, N.C.

GRANTI, WALTER ANTON HENRY (Assoc. M. '25, M. '33), Asst. to Gen. Mgr., Ferrocarril Terminal Central de Buenos Aires, Estacion Federico Lacrose, Buenos Aires, Argentine Republic.

GREENEFIELD, SERGE JOSEPH (Jun. '30; Assoc. M. '33), Asst. Engr., New York and Queens Elec. Light & Power Co. (Res., 191-05 State St.), Flushing, N.Y.

GROVER, NEWELL ARTHUR (Jun. '28; Assoc. M. '33), Draftsman, State Dept. of Highways (Res., 116 Frederick St.), San Francisco, Calif.

HOLMES, HAROLD RISTINE (Assoc. M. '25; M. '33), Chf. Field Engr., Bureau of Sewers, City Hall (Res., 2734 North Stowell Ave.), Milwaukee, Wis.

HOOPER, ELMER GUY (Assoc. M. '21; M. '33), Prof. of Hydraulics, New York Univ., 181st St. and University Ave., New York, N.Y.

JONES, HENRY MACY (Assoc. M. '23; M. '33), Civ. Engr., 906 California State Bldg., Los Angeles, Calif.

MILLER, JOHN ANDERSON (Jun. '22; Assoc. M. '24; M. '33), Editor, *Transit Journal*, McGraw-Hill Pub. Co., 330 West 42d St., New York, N.Y.

MORRISON, WALTER GORDON (Jun. '27; Assoc. M. '33), Care, West's Rotinoff Piling & Constr. Co., Regent House, Kingsway, London, W.C.2, England.

NELSON SAMUEL BALDWIN SMITH (Jun. '27, Assoc. M. '33), Asst. Field Engr., Dept. of Water and Power (Res., 251 South Larchmont Boulevard), Los Angeles, Calif.

NIXON, SAM AB (Jun. '30; Assoc. M. '33), Care, Office of Coll. Archt., Agri. and Mech. Coll. of Texas, College Station, Tex.

ROSS, CONRAD MILTON (Assoc. M. '26; M. '33), Civ., San., and Constr. Engr., Box 1175, Charleston, W.Va.

RUMBLE, GEORGE BERTYL (Jun '26; Assoc. M. '33), Asst. Engr., Albright & Friel, Inc. (Res., 1805 Cheltenham Ave., West Oak Lane), Philadelphia, Pa.

SPEIR OSWALD (Jun '19; Assoc. M. '22; M. '33), 528 Hopkins Ave., Redwood City, Calif.

WAGENER, FREDERICK WILLIAM (Jun. '31; Assoc. M. '33), Asst. Hydr. Engr., U.S. Geological Survey, 801 Loan and Exchange Bldg., Columbia, S.C.

WILHELM, FREDERICK EDWARD (Assoc. M. '24; M. '33), Associate Engr., U.S. Bureau of Reclamation (Res., 2279 Krameria St.), Denver, Colo.

WILSON, WILLIAM MUNSEY (Assoc. M. '28; M. '33), Chf. Structural Engr., F. E. Giesecke, Norwood Bldg., Austin, Tex.

REINSTATEMENTS

HEALY, FREDERIC GEORGE, Assoc. M., reinstated July 19, 1933.

STILES, ARTHUR ALVORD, M., reinstated July 17, 1933.

RESIGNATIONS

BAILIFF, NORMAN BOYD, Jun., resigned July 25, 1933.

HOUSTON, LAWRENCE ANDREW, Jun., resigned July 20, 1933.

MCCONOCHIE, WILLIAM ROBERT, Jun., resigned July 19, 1933.

SULLIVAN, EDMUND CAREY, Assoc. M., resigned July 10, 1933.

TAYLOR, GORHAM ANDREW, M., resigned July 11, 1933.

WAGSTAFF, JOHN PERRY, Assoc. M., resigned July 12, 1933.

WERNER, AUGUST JOHN, M., resigned July 19, 1933.

DEATHS

BAXTER, JOHN CRICHTON. Elected M., July 11, 1927; died July 27, 1933.

BRENNAN, EDWARD MICHAEL. Elected Assoc. M., Apr. 16, 1918; died June 11, 1933.

COUCHOT, MAURICE CHARLES. Elected Assoc. M., Nov. 1, 1905; M., June 2, 1908; died June 29, 1933.

DAVIS, ARTHUR POWELL. Elected Assoc. M., June 7, 1893; M., Oct. 4, 1899; died Aug. 7, 1933.

FINKBAUM, HARRY JACOB. Elected Assoc. M., Nov. 25, 1919; M., Jan. 18, 1932; died July 4, 1933.

MULLEN, CHARLES AUGUSTINE. Elected Assoc. M., Nov. 27, 1917; M., June 6, 1921; died July 13, 1933.

OTIS, GEORGE ELLISON. Elected M., July 3, 1895; died July 9, 1933.

WALKER, LELAND ROSS. Elected Assoc. M., Nov. 9, 1920; M., July 16, 1928; died June 23, 1933.

YOUNG OLIVER EARLE. Elected Jun., June 6, 1911; Assoc. M., Mar. 4, 1913; died July 1933.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1933 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

CONSTRUCTION

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; one child. Licensed construction engineer and land surveyor in New Jersey. Passed first year of law school in New Jersey. Qualified to teach engineering subjects in secondary schools. Will take anything reasonable. D-198.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; B.S. in C.E., New York University, 1928; 5 years general engineering experience, especially industrial, building, and road construction; supervision of such; also surveying, estimating, and engineering reports. Desires position in any of these capacities, field or office work. Location, vicinity of New York State. Available immediately. C-4704.

SUPERINTENDENT OF CONSTRUCTION; M. Am. Soc. C.E.; experienced in bakery and brewery construction, handling all physical problems for either the owner's end or contractor's; able to take complete charge. C-7840.

ENGINEER-ESTIMATOR ON CONSTRUCTION; M. Am. Soc. C.E.; 30; married; desires to locate with contractor; 10 years experience on reinforced concrete, steel, and masonry structures. Location immaterial. Salary will be a secondary consideration. C-5673.

DESIGN

STRUCTURAL DESIGNER; Jun. Am. Soc. C.E.; 29; college graduate; married; 3 years experience on design of hydraulic structures, including dams, pumping plants, locks, marine ways, bridges, culverts, and buildings. Excellent computer and estimator and capable of writing intelligent engineering reports. Will go anywhere at any reasonable salary. D-2430.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; Mem. A.W.W.A. and Penn. Sewage Works Assn.; 38; married; Cornell graduate; experienced in all phases of water works and sewerage design and construction; has been connected with at least 30 water works and sewerage projects; active student; can handle design or construction with a minimum of supervision. C-6422.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate C.E.; 33; married; 10 years experience in design of reinforced concrete and structural steel bridges, steel plants, blast furnace, skip bridges, indeterminate structures, heavy foundations. Writes and speaks German and French perfectly. Suitable man for foreign work. Available at once. Location and salary secondary. D-2019.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; 25; married; B.S. in C.E. and M.S. in sanitation; 6 years with official departments of health; 4 years with consulting engineers on water supply, water purification, sewerage, and sewage treatment. B-8539.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 9 years varied structural experience; drafting, design, surveys, and construction. Desires position in field or office in any capacity with opportunity to use ability. Sales-engineering or instructorship also considered. C-2605.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 36; married; graduate; 13 years experience in drafting, designing, and estimating of industrial buildings of structural steel, reinforced concrete, and timber construction. Familiar with foundation design. Assistant engineer designing for vehicular tunnels. Capable of checking design and details on construction drawings. B-7650.

STRUCTURAL DESIGNER AND SALES ENGINEER; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Large acquaintance among architects, engineers, builders, and contractors in northern New Jersey. A-5489.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate of Polytechnical University, 1919, C.E. degree. Extensive experience in statically indeterminate structures and arches. Engineering since graduation; 8 years with foremost concern, designing power plants, transmission lines, industrial buildings, wind-bracing, tall buildings. Recently in charge of design of several toll bridges. (R.F.C. project.) B-5176.

CIVIL AND STRUCTURAL ENGINEER; M. Am. Soc. C.E.; graduate; licensed. Over 20 years experience in the detailing, designing, estimating, and fabrication of structural steelwork for all classes of structures; industrial plants, hydro-electric developments, commercial garages, service

stations. Specifications, obtaining bids, letting contracts, supervision of office and field forces. B-2835.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; married; graduate, state licenses; 10 years experience, surveying, design, and construction. Railroad, highway, parkway, harbor, and tall building projects. Completely familiar with the design of rigid-frame bridges, reinforced concrete or steel, single or multiple span, square or skew. Available immediately. D-1496.

EXECUTIVE

STRUCTURAL ENGINEER EXECUTIVE; M. Am. Soc. C.E.; 45; married; long successful record in steel fabricating business in connection with estimating, designing, pricing, and sales as well as district representation in Ohio and western Pennsylvania for a leading concern. Has extensive trade acquaintance. Available immediately. C-5095.

STRUCTURAL DESIGNER; Assoc. M. Am. Soc. C.E.; 34; 8 years experience in design, drafting, and construction of structural steel, reinforced concrete, and timber structures in engineering offices; layout and development of industrial plants; location absolutely immaterial. Available at present. Speaks Russian. D-119.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 40; single; graduate of University of Virginia, M.A., C.E.; 16 years experience on surveys and construction of hydro-electric developments, transmission lines, industrial plants, housing developments, estimating, and appraisals; 3 years in Chile. Now employed, but can fill better position. Available on two weeks notice to present employer. Speaks Spanish. Will go anywhere. C-5318.

PATENT ATTORNEY; Assoc. M. Am. Soc. C.E. Capable of organizing and managing patent department. University graduate. Professional engineering degree. Member of New York Bar. Registered U.S. and Canadian patent attorney. Broad business experience; 8 years patent experience with old established patent law firm and patent department of large corporation. B-1819.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 36; single; licensed New York State and New Jersey; C.E. degree; 1 year production engineering; 11½ years civil engineering, last 6 years in responsible charge. Desires work in production or engineering department of large company or with water works. A-962.

EXECUTIVE; Assoc. M. Am. Soc. C.E.; civil engineer; registered; graduate of University of Michigan; 21 years experience, topographic surveys, hydro-electric development, highway surveys, construction, maintenance; last 3 years in responsible charge of organization and administration of right-of-way division for State Highway Department, condemnation private property. Good organizer. Available immediately. D-2437.

JUNIOR

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 25; graduate of University of Missouri, B.S. in C.E.; 1 year sewer construction, field and office; 9 months railroad experience; desires position with consulting or sanitary engineer. References upon request. Location immaterial. Available immediately. C-7529.

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 22; single; B.S. in C.E., California Institute of Technology, 1932. Training includes knowledge of shorthand and typewriting. Desires employment of any sort. Location immaterial. Available immediately. D-2369.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; B.S. in C.E.; single; 7 years experience in water works and building construction. Excellent draftsman. Available now. Location and salary open. D-2211.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; major in economics; registered professional engineer; 3 years in highway work; desires business position requiring engineering training. D-2368.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.C.E., Polytechnic Institute of Brooklyn, 1932; 9 months as transitman, estimator, and assistant to construction engineer; 6 months as construction engineer; responsible charge of engineering work in construction of reinforced concrete floor arches for five three-floor state buildings. Also did timekeeping. Desires work with contractor. Location immaterial. Available immediately. D-2386.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 21; single; B.S. and M.S. in C.E., Georgia School of Technology; little experience during summers; teaching or railroad work preferred; good draftsman. Salary secondary to chance for advancement. Location immaterial. D-2202.

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of University of Colorado; B.S. (A.E.), 1932; M.S. (C.E.), 1933; desires position in any branch of civil or architectural engineering. Available immediately. Location immaterial. D-2401.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 32; single; B.S. in C.E.; 1927; 3 years as instrumentman, computer, inspector, and in charge of party on surveys and construction of concrete highways and appurtenances; 2 years drafting and general office work in consulting sanitary engineer's office; 1 year assisting on appraisal of water works. Available immediately. C-1421.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; C.E. and D.C.E. from Rensselaer Polytechnic Institute; 1 years experience teaching mathematics and drawing; 4 years experience as assistant to professor in summer surveying courses. Desires work in any branch of civil engineering—preferably structural—field or office. Available immediately. D-2390.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; graduate of Rensselaer Polytechnic Institute; 1 years experience as assistant engineer in Building Construction; 1 month on bridge construction. Field knowledge of bookkeeping. Estimating. Good draftsman. Surveying. Computations a specialty. Excellent understanding of Italian. Speaks French. Willing to learn. Good references. Available now. Location immaterial. D-2423.

MISCELLANEOUS

ENGINEER; Assoc. M. Am. Soc. C.E.; 31; very neat appearance; conversational ability; desires personal contact work; 10 years experience bridges, road building, estimating design. Working knowledge mechanical practice. Very neat systematic office man. As second choice, interested in drafting work. Would consider selling. Available immediately. Go anywhere including foreign countries. D-2398.

SALES

SALES MANAGER AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E. Successful record coordinating sales and production, market determinations, personnel organization, and management. Specialist in mechanical handling of materials. Experienced in all types of construction work and materials. Pacific Coast preferred but not essential. B-4219.

TEACHING

CIVIL ENGINEER; M. Am. Soc. C.E.; 15 years of locating, construction, and design of railroads in Russia; 4 years of teaching applied mechanics, differential and integral calculus in China; 3¼ years of research in United States; commands German, Russian, French; desires teaching, research, designing, or consulting position. Location immaterial. D-2399.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; master's degree in C.E., Cornell University; 3 years experience with steel companies and general contractors; 3 years experience in all classes of surveys, including triangulation and hydrography. Desires teaching, engineering, or surveying position. Location immaterial. Salary secondary. D-2384.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; B.S. in C.E., Michigan State. Experience: highway and railway relocations—cost and design; design and construction of marine structures; acquainted modern factory conveyors; with Corps of Engineers, U.S. Army, 4½ years; executive experience. Desires position with consulting engineer or teaching. Excellent references. Available about September 1. Location immaterial. D-2425.

RECENT BOOKS

New books of interest to Civil Engineers, donated by the publishers to the Engineering Societies Library or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1933. These notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

ANALYSIS AND DESIGN OF STEEL STRUCTURES. By A. H. Fuller and F. Kerekes. Ames, Iowa, Power Press, 1933. 451 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth, $5.

A textbook for undergraduate students of civil and architectural engineering, based upon the courses given by the authors at the University of Iowa. The material is presented from the viewpoint of the student undergoing his first experience in structural work, as a connecting link between class work in mechanics and engineering work in the field and office. Problems are used extensively.

FROM PLAN TO REALITY. New York, Regional Plan Association, 1933. 142 pp., illus., tables, maps, 11 × 9 in., cloth, $2.

This report supplements the study of communication facilities and land uses published by the Regional Plan Association in 1929 by describing the development of the metropolitan region during the intervening four years. Present needs are considered.

MULTIPLE-LENS AERIAL CAMERAS IN MAPPING. By the Technical Staff of the Fairchild Aerial Camera Corporation. New York, Fairchild Aerial Camera Corporation, 1933. 176 pp., illus., diagrs., charts, tables, 6 × 9 in., cloth, $5.

This treatment of the subject was planned especially for the engineer. It emphasizes points that will enable him to know when, how, how economically, and with what results this method of photography may be applied to procuring map data. The production of the photographs and their conversion into maps for various engineering needs are thoroughly covered, and the final chapter includes information on the planning or direction of aerial mapping missions.

PRINCIPLES OF INDUSTRIAL ORGANIZATION. By D. S. Kimball. 4 ed. New York and London, McGraw-Hill Book Company, 1933. 460 pp., illus., charts, tables, 9 × 6 in., cloth, $4.

The scientific background of production and the methods and mechanisms of management that have been devised to control it are clearly and concisely presented in this textbook for engineering students.

PUBLIC UTILITIES AND THE PEOPLE. By W. A. Prendergast. New York and London, D. Appleton-Century Company. 379 pp., tables, 8 × 6 in., cloth, $3.

The former chairman of the Public Service Commission of the State of New York presents a timely discussion of utility companies in general and electric utilities in particular. Such controversial questions as the "power trust," holding companies, valuation, rates, regulation, and public ownership are considered fully.

REAL ESTATE APPRAISAL AND VALUATION. By P. W. Kniskern. New York, Ronald Press, 1933. 532 pp., charts, tables, 9 × 6 in., cloth, $6.

The economic and other principles that control value in real estate and simple, practical methods of applying these principles to specific cases.

VALUE THEORY AND BUSINESS CYCLES. By H. L. McCracken. New York, Falcon Press, 1933. 270 pp., charts, 9 × 6 in., cloth, $4.

In the first book of this volume the embodied value theory is examined critically. The second book treats the commanded value theory in a similar way, while the third book discusses the problem of business equilibration. The work is a timely discussion of pressing problems.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

ABUTMENTS. Economy in Abutment Design for Short-Span Bridges. *Roads and Road Construction*, vol. 11, no. 125, May 1, 1933, pp. 144–147. Advantages of vertical beam abutments; safety; simplicity of design and construction; uniform distribution of bearing pressure; prevention of creep; economy; design of vertical beam abutment; footing design; tabulated comparison of designs.

CONCRETE ARCH, AUSTRALIA. Grey Street Bridge, Brisbane, A. E. H. Frew. *Concrete and Constr. Eng.*, vol. 28, no. 6, June 1933, pp. 354–364. Design and construction of highway bridge 1,634 ft. long, consisting principally of three main arches of 238-ft span, carrying a roadway 40 ft wide; concrete cylinders take thrust from 90-ft arch; piers of viaduct; surface finish; lighting.

DENMARK. Great Danish Rail and Road Bridge. *Ry. Engr.*, vol. 54, no. 640, June 1933, pp. 164 and 165. Contract signed by Dorman, Long and Company and Danish State Railways for the construction of: combined rail and road bridge across Storstroemmen, about 2 miles in length; smaller bridge over the Masnedsund, 1/8 mile in length; and some 9 or 10 km of rail and road, including bridge approaches.

FLOORS. Irving Open-Mesh Bridge Decking. *Engineering*, vol. 135, no. 3517, June 9, 1933, p. 636. Irving Iron Works Company, Long Island City, N.Y., have produced pattern of open mesh in which all joints are staggered; meshing consists of longitudinal reticulated bars.

GOLDEN GATE. Golden Gate Bridge Work Makes Progress. *Eng. News-Rec.*, vol. 111, no. 1, July 6, 1933, pp. 7 and 8. Progress report on the construction of piers and anchorages; subaqueous blasting and excavating for south pier; San Francisco anchorage site excavation; batching plants for truck-mixers.

LIFT, CONSTRUCTION. Builds New Tennessee River Bridge. *Ry. Age*, vol. 94, no. 24, June 17, 1933, pp. 858–860. Vertical-lift span, 294 ft 4 1/2 in. long, is the primary feature of a new steel truss bridge, with a total length of 1,571 ft, across the Tennessee River at Danville, Tenn., completed late in 1932 by Louisville and Nashville; pneumatic foundations; erection on falsework; features of lift span and operating control.

ONTARIO. Englehart Bridge Over White River Carries Ferguson Highway. J. S. Leitch. *Can. Engr.*, vol. 64, no. 24, June 13, 1933, pp. 5–8. Design and construction of steel-truss highway bridge; 800 ft total length; 160-ft maximum span; construction of foundations; steel erection methods; bank protection.

PIERS, GOLDEN GATE BRIDGE. Main Piers and Fender, Golden Gate Bridge, F. W. Crocker. *Western Construction News and Highways Bldr.*, vol. 8, no. 11, June 10, 1933, pp. 263–269. Construction of the San Francisco pier of the Golden Gate Bridge, 1,100 ft offshore, consisting of a footing course 90 by 185 ft in plan and 50 ft deep, and a concrete pier base 94 ft high, top area being 65 by 134 ft; construction of Marin Pier consisting of a concrete base block 80 by 160 ft in plan and 10 ft deep; shaft 54 ft high; base area 72 by 149 ft; top 65 by 134 ft.

PILES, WOODEN, CONCRETE ENCASEMENT. Concrete Jackets Protect Timber Piles Exposed to Sea Water, J. W. Barnswell, Jr. *Concrete*, vol. 41, no. 6, June 1933, pp. 3–5. Practice of South Carolina Highway Department extends life of timber along sea coast; working procedure and tabulation of cost data; concrete protecting jackets seem to offer one of the most effective means of checking depredations of marine pests; procedure followed in encasement of piles.

PLATE GIRDER, CONSTRUCTION. Rolling 400-Ton Railway Span Into Position from Falsework, G. B. Taylor. *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, p. 775. Erection of new plate-girder span, weighing 400 tons, carrying tracks of the New York, New Haven, and Hartford Railroad over Connecticut state highway No. 108, at Buckland, Conn.; falsework and grillage arrangement used in rolling into position.

RECONSTRUCTION. Methods of Reconstructing Old Steel Bridges, C. A. Melick. *Roads and Streets*, vol. 76, no. 6, June 1933, pp. 236–239 and 242–244. Stringer spacing and capacity; increasing stringer capacity; strengthening floor beams and truss members; repairing and raising truss shoes; widening truss bridge.

STEEL, CORROSION PREVENTION. Fighting Corrosion in Bridge Maintenance, W. R. Roof. *Ry. Eng. and Maintenance*, vol. 29, no. 7, July 1933, pp. 323–325. Laboratory tests demonstrate the strength of welded connections of wrought iron plates to steel members and point to the advantage of using them in reinforcing work; effect of brine drippings; test specimens.

BUILDINGS

EARTHQUAKE EFFECTS. Survey of Long Beach Earthquake Damage, C. D. Wailes, Jr., and A. C. Horner. *Western City*, vol. 9, no. 6, June 1933, pp. 7–10. Study of structural features of damaged and non-damaged buildings demonstrating the necessity for designing new buildings to resist lateral force and making existing structures as safe as is economically feasible.

EXHIBITION BUILDINGS, CHICAGO. World's Fair Buildings. *Construction Methods*, vol. 15, no. 6, June 1933, pp. 18–21. Review of new materials and methods of construction; foundations; steel framing; deck construction; roofs; exterior wall coverings; interior wall and ceiling covering; ventilation; special features.

OFFICE BUILDINGS, TORONTO. Construction Details of New Million-Dollar Office Building of Toronto Hydro-Electric System. *Eng. and Contract Rec. (formerly Contract Rec.)*, vol. 47, no. 26, June 28, 1933, pp. 625, 627, 629, and 631–637. Design and construction of a 9-story L-shaped office building occupying a lot 156 ft by 250 ft deep; architecture and layout; structural design; mechanical equipment; boilers; heating system; air conditioning; plumbing; electrical system; elevators.

CITY AND REGIONAL PLANNING

MAPPING. Notes on Development of Cartographic Representation of Cities, M. I. Fead. *Geographical Rev.*, vol. 23, no. 3, July 1933, pp. 441–456. Development from early times; perspective and horizontal plans; some early maps of Jerusalem; sixteenth and seventeenth century maps; beginnings of conventionalization; ground plan in nineteenth century; morphological and functional ground plans; modern trends in city maps.

SWITZERLAND. Planning Geneva, Switzerland, P. Bradley. *City Planning*, vol. 9, no. 3, July 1933, pp. 103–113. Description of city having a population of 140,000; conflicts between railway and highway; official plan for reconstruction of Quartier St. Gervais; reconstruction of right bank; housing.

TENNESSEE. Tennessee Valley Development. *Mfrs. Rec.*, vol. 102, no. 6, June 1933, pp. 14–17. Outline of projects of recently organized Tennessee Valley Authority; power possibilities; nitrate plants; Cove Creek power dam; power resources of Tennessee River basin; raw materials for diversified industrial development.

WATER WORKS. Water Supply in Relation to City and Regional Planning, M. Pirnie. *Water Works and Sewerage*, vol. 80, no. 6, June 1933, pp. 189–191. Dual use of rights of way and conserved water-supply areas; abandonment of water works because of inadequate or polluted supplies; zoning as applied to water-supply construction; pay-as-you-go plan of public works construction; public works as balance wheel in maintaining employment.

CONCRETE

AGGREGATES, RAILROAD TRANSPORTATION. Aggregate-Production Data Show Trend to Motor-Truck Transportation, H. H. Hughes, A. T. Coons, F. G. Tryon, and F. E. Berquist. *Pit and Quarry*, vol. 25, no. 9, May 1933, pp. 17 and 18. Data assembled by the U. S. Bureau of Mines revealing the relationship of railroad shipments of aggregates to total production, as well as estimates of 1932 production of sand and gravel and crushed stone.

ANALYSIS. Testing for Diatomaceous Earth, J. L. Heitzman and A. S. Peiper. *Eng. News-Rec.*, vol. 110, no. 25, June 22, 1933, p. 801. Microscopic method of determining the presence of diatomaceous earth in concrete, involving the disintegration of concrete by rapid cooling from high temperature.

CEMENT, FINENESS. How Fineness of Cement Affects Strength of Concrete, W. E. Corbett. *Concrete*, vol. 41, no. 6, June 1933, pp. 8 and 9. Percentage of fine flour controls strength of cement; greater fineness also improves workability; detailed tests on subject needed; practical limitation to degree of fineness.

CONSTRUCTION. Truck-Mixed Concrete for Golden Gate Bridge, A. G. Darwin. *West. Construction News and Highways Bldr.*, vol. 8, no. 11, June 10, 1933, pp. 269–272. Handling of aggregates, mixing procedure, and distribution of concrete; Marin and San Francisco batch plant.

COLORING. Dyeing Stone and Concrete. *Concrete Bldg. and Concrete Products*, vol. 8, no. 6, June 1933, p. 1056. Review of old and new recipes.

FORMS. What Pressure on Concrete Forms? *Concrete*, vol. 41, no. 6, June 1933, pp. 6 and 7. Long-used pressure diagram of P. R Shunk believed much too severe; modern cement shortens time of initial set; acceptance of E. B. Smith's formula urged.

HANDLING. Demoistured Air Aids Madden Dam Content, A. J. Ackerman. *Eng. News-Rec.*, vol. 111, no. 1, July 6, 1933, pp. 11–13. Handling difficulties caused by annual rainy season of eight months in Canal Zone overcome by using sealed steel silos, pneumatic transportation, and demoistured air; trucks for hauling cement.

READY-MIXED CONCRETE PLANTS, NEBRASKA. Wins General Acceptance of Its Product in Two Years of Operation. *Pit and Quarry*, vol. 25, no. 9, May 1933, pp. 23 and 24. Design, operation, and equipment of the central concrete mixing plant of the Ready-Mixed Concrete Company, Lincoln, Nebr.; product is employed in every type of construction; plant is of all-steel-and-concrete construction.

REINFORCEMENT, ANCHORAGE. Tests of Anchorages for Reinforcing Bars, C. J. Posey. *Univ. Iowa—Studies' in Eng.—Bul.*, Three New Series, no. 257, Aug. 15, 1933, 31 pp. Report on experimental investigation to find an anchorage giving high ultimate values of spirally reinforced hooks, but without their tendency toward excessive slip; comparison of load-slip curves for hooks of different radii but the same length of embedment; comparison of load-slip curves for straight embedments.

CONSTRUCTION INDUSTRY

COSTS. Unit Prices—Eleven Levee Sections, Mississippi. *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, pp. 793 and 794. Unit costs bid on construction of Mississippi River relief levees in the Upper Yazoo district; also on 2.6 miles of asphalt airport runway of the Shushan Airport, New Orleans, La.

DAMS

AUSTRALIA. Mount Bold Storage, Adelaide Metropolitan Water Supply, H. J. O. Eaton and T. A. Farrent. *Inst. Engrs. Australia—Journal*, vol. 5, no. 5, May 1933, p. 175. Discussion of paper previously indexed from issue of February 1933.

CONCRETE GRAVITY, LONDONDERRY, IRELAND. Altnaheglish Dam, Londonderry, W. Criswell. *Concrete and Constr. Eng.*, vol. 28, no. 6, June 1933, pp. 381–390. Design and construction of curved concrete-gravity water supply dam; about 130 m. maximum height; layout of construction plant; contraction joints; pressure-relief underdrains.

DEBRIS. **Eaton Wash Debris Dam near Pasadena, E. C. Eaton.** *West. Construction News and Highways Bldr.*, vol. 8, no. 11, June 10, 1933, p. 262. Gravel-fill structure—52 ft maximum height, 1,500 ft long—to be built by the Los Angeles County Flood Control District.

EXPANSION JOINTS. **Note sur la forme des joints de contraction dans les barrages à gravité, A. Renaud.** *Annales des Ponts et Chaussees, (Partie Technique)* vol. 1, no. 1, Jan.-Feb. 1933, pp. 32–50. Design of contraction expansion joints for gravity dams, with special reference to offset form of joint; review of French practice and summary of observations on joints of French masonry dams.

GREAT BRITAIN. **Features of Construction of Ryburn Dam, J. N. Wood.** *Surveyor*, vol. 83, no. 2159, June 9, 1933, p. 603; see also *Water and Water Eng.*, vol. 35, no. 419, Midsummer 1933, pp. 351–360 (discussion) 361–368. Design and construction of curved concrete gravity water-supply dam, maximum height 121 ft, located near Ripponden, Yorkshire; layout and plant; concreting gantries; concrete proportions and testing; contraction joints; cementation of cut-off trench; underdrains; valve shaft; filter house and gage basins. Before Inst. Engrs.

HOOVER DAM PROJECT, CONSTRUCTION. **Handling 2,000,000 Cu Yd of Excavation at Hoover Dam.** *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, pp. 776–780. Rock from canyon walls and river-bed gravel moved out by truck fleet and trains; cofferdam construction coordinated with excavating program; daily peak reaches 7,200 truckloads, or about 38,000 cu yd; stream-bed excavation.

MASONRY, RAISING. **Heightening of Aswan Dam.** *Engineer*, vol. 155, no. 4038, June 2, 1933, pp. 542–545 and supp. plates. In 1912 first heightening, which brought capacity up 2,400 million cu m was completed; work on second heightening was begun in November 1929; various phases of work of raising dam; reconstruction of lock system; costs.

FLOOD CONTROL

CHINA. **Northern River Problem in China, S. Eliassen.** *Assn. Chinese and Am. Engrs.—Journal*, vol. 14, no. 3, May 1933, pp. 21–28. General review of flood conservancy problems of Northern China; climatic and geologic factors. (In English.)

HELENA, ARK. **Concrete Wall Replaces Levee at Helena, Ark., H. V. Pittman.** *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, pp. 780–784. Old 1914 levee surmounted by concrete wall, with sheet-pile cut-off down to 60-ft depth, is substituted for enlarged 1928 section levee; wall design and construction procedure; method and cost of driving steel sheet piling; cost of constructing 3,161 ft of concrete flood-protection wall on the Mississippi River.

MISSISSIPPI RIVER. **New Plans for the Mississippi.** *Eng. News-Rec.*, vol. 110, no. 25, June 22, 1933, pp. 795–801. General review of present program; stabilization and capacity increase; rectification and slope regulation; model-experiment attack on river problems; floodway questions; channel straightening by cut-offs; detritus movement; revetment investigations; spur-dike contraction works.

FOUNDATIONS

PILE DRIVING. **Development of Modern Piling Technique, C. Helsby.** *Civ. Eng. (London)*, vol. 28, no. 323, May 1933, pp. 173–177. Review of pile-driving practice, especially in Great Britain.

UNDERPINNING. **Cliff-Dwellers of 1000 A.D. as Underpinning Experts, J. B. Hamilton and F. A. Kittredge.** *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, pp. 774 and 775. Primitive engineering effort made by early American cliff-dwellers to brace up a detached cliff section weighing 30,000 tons that threatened their pueblo, in Chaco Canyon National Monument.

HYDRO-ELECTRIC POWER PLANTS

CANADA. **Considerations Governing Location of Hydro-Electric Developments on Upper St. Maurice River, C. R. Lindsey.** *Eng. Journal*, vol. 16, no. 7, July 1933, pp. 293–300. Hydro-electric possibilities in stretch of St. Maurice River on which the difference of level is 630 ft in 78 miles; geological history and characteristics of the river and its drainage basin; photographic methods of topographic surveying; electrical methods used to determine the depth of bedrock on dam sites; plans for six developments with a total capacity of over 1,000,000 hp. Before Eng. Inst. Can.

GREAT BRITAIN. **Severn Barrage Scheme.** *Machy. Market*, no. 1689, March 17, 1933, pp. 15, 16, and 30. Previously indexed from *Engineering*, April 7, 1933.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

CALIFORNIA. **Engineers and Geologists Find Much of Interest in Results of Recent California Earthquake.** *Oil Weekly*, vol. 69, no. 11, May 29, 1933, pp. 33–35. Notes on effect of earthquake of March 10, 1933, at Huntington Beach, Long Beach, and Seal Beach; orifice meters acted as seismographs; one meter chart record at Hungtington Beach indicated disturbance two days before the major shock arrived; geological data; little damage done in wells.

EARTHQUAKES, CALIFORNIA. **Destructive Earthquake Motions Measured for First Time, N. H. Heck and F. Neumann.** *Eng. News-Rec.*, vol. 110, no. 25, June 22, 1933, pp. 804–807. Reproduction of high accelerations in Long Beach earthquake as shown by a strong-motion accelerograph at three stations in Southern California.

SHORE PROTECTION. **Save the Golden Band of Ocean Beaches, V. Gelineau.** *Eng. News-Rec.*, vol. 110, no. 24, June 15, 1933, pp. 765–771. Value of New Jersey ocean beaches; physics of beaches; destruction of beaches and methods of beach protection; details of bulkhead and jetty construction of timber pile and cribwork, with stone fill, employed for beach protection on the New Jersey coast; types of seawalls, mostly stone and concrete.

INLAND WATERWAYS

REGULATION. **Regulation of Colorado River, C. C. Elder.** *Am. Water Works Assn.—Journal*, vol. 25, no. 6, June 1933, pp. 793–802. Analysis of the regulating effect of storage at Boulder Dam on the flow of the Colorado River; objectives of regulation; discharge records; Colorado River silt; rate of settling of silt; Colorado River dissolved solids.

RIVERS, IMPROVEMENT. **New Plans for Mississippi.** *Eng. News Rec.*, vol. 110, no. 26, June 29, 1933, pp. 838–842. Hydraulic efficiency of tortuous channel of the Mississippi improved by a series of artificial channels cutting off river loops; model tests controvert old beliefs as to danger of cut-offs to channel regimen; cut-off tradition; experimental studies; construction program.

IRRIGATION

CANALS, DESIGN. **Mathematics of Canal Fall Cistern, T. Blench.** *Indian Eng.*, vol. 95, no. 21, May 27, 1933, pp. 412–414. Mathematical analysis of fundamentals for the design of stilling basins, downstream of canal drops, and weirs; determination of downstream depth required to ensure that the energy which would cause damage is used up in standing wave; rules for design.

SUDAN. **Sudd Region of Nile, H. E. Hurst.** *Engineer*, vol. 155, no. 4039, June 9, 1933, p. 586. Sudd is a word applied to masses of swamp vegetation, grass reeds, papyrus, etc., which occasionally block some of the tributaries of the White Nile; possible projects on the Upper Nile for storing silt-free water to meet future increases of summer cultivation. Before Roy. Soc. Arts.

TEXAS. **Irrigation in Lower Rio Grande Valley of Texas, E. J. Foscue.** *Geographical Rev.*, vol. 23, no. 3, July 1933, pp. 457–463. Non-technical review of recent developments, with special reference to its international aspects; statistical data.

WEIRS, DIVIDING WALLS. **Dividing Walls, R. K. Varma.** *Indian Eng.*, vol. 93, no. 22, June 3, 1933, pp. 436–438. Mathematical analysis of principles of the design of dividing walls upstream of regulating weirs, with special reference to weirs having ends not at the same level.

LAND RECLAMATION AND DRAINAGE

ITALY. **Le opere di completamento della bonifica di Valdichiana, A. Rampazzi.** *Annali dei Lavori Pubblici*, vol. 70, no. 12, Dec. 1932, pp. 1025–1033, 6 supp. pp. and 1 supp. plate. Completion of Valdichiana land reclamation project, developing since 1840.

MATERIALS TESTING

COLUMNS, CONCRETE. **Fifth Report on Column Tests at Lehigh University, I. Lyse.** *Am. Concrete Inst.—Journal*, vol. 4, no. 9, June 1933, pp. 433–442. Continuation of report indexed in Engineering Index 1931, p. 314; and 1932, p. 281; tests on amount of load reinforced concrete column will sustain indefinitely; load deformation diagram; stress-strain curve for tension rods; effect of percentage of spiral reinforcement on ultimate strength of columns saving 4 per cent longitudinal reinforcement; fast loading; time effect; deformation of column under sustained load; effect of release of load.

STRESSES, ANALYSIS. **Effect of Local Heterogeneity on Stress Distribution in Solids, K. Sezawa.** *Engineering*, vol. 135, no. 3520, June 30, 1933, pp. 695–696. Study of the problem of stress distribution in a body having cylindrical or spherical heterogeneity and subjected to tension or compression.

MUNICIPAL ENGINEERING

AMUSEMENT PARKS, EQUIPMENT. **World's Fair Aerial Cars Travel on Cables from Skyway Towers.** *Construction Methods*, vol. 15, no. 6, June 1933, pp. 34–36. Development of skyway project consisting of transporter suspension bridge with a 1,850-ft span crossing a lagoon and exposition buildings; rocket cars travel at a speed of 520 ft per min on a horizontal rope tramway, more than 200 ft above the ground; tramway system; suspension system; elevators.

PORTS AND MARITIME STRUCTURES

CARGO HANDLING EQUIPMENT. **Modern Stevedoring Reduces Costs, H. B. Madison.** *World Ports*, vol. 21, no. 7, May 1933, pp. 14, 15, and 26. Notes on conveyors and other equipment for handling and segregating local, through, rail, or water freight.

CHINA. **Present Status of Site of Great-Northern-Port, Shu-Tlien Li.** *Assn. Chinese and Am. Engrs.—Journal*, vol. 14, no. 3, May 1933, pp. 1–20. Project of new port on the Gulf of Pohai opposite Port Arthur; geographic features; climate; communication by land and sea with Great-Northern-Port; present import and export; present status of fishing and salt industries; value of land in vicinity; availability of construction materials; Great-Northern-Port versus other ports. (In English.)

CORROSION. **Deterioration of Structures in Sea Water.** *Engineering*, vol. 135, no. 3520, June 30, 1933, p. 709. Editorial review of thirteenth interim report issued by the Great Britain Department of Scientific and Industrial Research (published by H. M. Stationery Office, price 1s. 6d. net), giving detailed information on investigations reported upon to committee from places all over the world.

DOCKS, SOUTHAMPTON. **Southampton Dock Extensions.** *Engineering*, vol. 135, no. 3517, June 9, 1933, pp. 611–613, and 624, supp. plates. Scheme adopted was that of reclaiming bay, which measures roughly 2 miles by ½ mile at its widest part; quay wall will provide berths for eight big ships in line; reclaimed area, which amounts to about 408 acres, is reserved for warehouses, storage areas, etc.; quay wall consists of a line of 146 concrete monoliths sunk to depths varying from 71 to 100 ft below quay level in gravel bank.

EQUIPMENT. **Des grues de port avec déplacement horizontal de la charge durant le mouvement de flèche et avec un appareil de pesage admis au poinçon officiel, F. Riedig.** *Manutention Moderne*, vol. 8, no. 5, May 1933, pp. 5–7. Features and performance of port cranes permitting horizontal displacement of load during elimination of sag and provided with weighing equipment.

GROYNES. **Adjustable Screw Pile Groynes.** *Engineer*, vol. 155, no. 4042, June 30, 1933, pp. 656 and 657. One of the most successful methods of preventing coast erosion is use of groynes, new type of low groyne has been patented, known as Du-Plat-Taylor adjustable groyne consisting of planks and screw piles.

ST. JOHN, N.B. **Harbor of St. John, New Brunswick.** *Engineer*, vol. 155, no. 4042, June 30, 1933, p. 650. Harbor is preeminently winter port; chief commodity is grain; in connection with big improvement scheme put in hand in 1928, access to port for shipping is being much improved.

TOKYO, JAPAN. **Harbor Development at Tokyo, W. H. Clarke, Jr.** *Far East. Rev.*, vol. 29, no. 4, April 1933, pp. 162–167. Historical notes; non-technical description of present harbor and outline of new port construction, which will cost a total of 33 million yen, including concrete arch highway bridge 246 m long.

ROADS AND STREETS

ASPHALT EMULSIONS. **Treatment of Road Surfaces with Bitumen Emulsions.** *Engineering*, vol. 135, no. 3518, June 16, 1933, p. 659. Results obtained in curing concrete by means of bitumen preparation sprayed on; coating remains effective as seal for months after it has been subjected to traffic; material used is bituminous emulsion known as Colas, produced by Colas Products Ltd.

BRICK. **Brick Pavement on Sand-Clay Base.** *Roads and Streets*, vol. 76, no. 6, June 1933, p. 217. Construction of brick surface on specially proportioned mixture of sand and clay as base in 5-mile road job in Dougherty County, Georgia.

CALIFORNIA. **Twin Pavers, J. S. Burch.** *Roads and Streets*, vol. 76, no. 6, June 1933, pp. 213–217. Equipment used in making progress records on the concrete paving of the Bayshore Highway in Santa Clara County, Calif.; daily paving progress on fabric reinforced job.

CONSTRUCTION. **Helping Nature Settle Fills in Rhode Island and Ohio, L. F. Livingston.** *Contractors and Engrs. Monthly*, vol. 26, no. 6, June 1933, pp. 27 and 28. Methods of blasting for the construction of highway fills in swampy ground in Rhode Island and Ohio.

DESIGN. **Wide Boulevard—Its Design and Control, J. R. Bibbins.** *Eng. News-Rec.*, vol. 110, no. 25, June 22, 1933, pp. 808–810. Long-time view on certain phases of economics involved in wide boulevard design; economic city planning, transportation technic, and financial limitations; comparative traffic features of proposed Lake Front Drive, Chicago, with eight free lanes, and Michigan Avenue with four free lanes; rail versus motor.

INDEX TO ADVERTISERS

INDUSTRIAL

The Society reserves the privilege of rejecting advertisements inconsistent with its ethical procedure.

Alphabetical Index to Advertisers Shown on Page 12

FINANCING. Illinois Financial Survey. *Pub. Roads*, vol. 14, no. 3, May 1933, pp. 37–51 and 56. Digest of survey of finances of Illinois in 1930, with special reference to highways, conducted by the Bureau of Public Roads and the University of Wisconsin; population and assessed valuation; method of obtaining data; taxes; motor-vehicle registration; special assessments; bonded indebtedness; debt service; expenditures analyzed; sources of revenues; relationships between taxes, travel, and expenditures.

GRADE SEPARATION. Les passages souterrains pour voitures des Portes Dauphine et de la Villette, à Paris, J. Thomas. *Génie Civil*, vol. 102, no. 22, June 3, 1933, pp. 516–519. Plans and structural details of grade separation structures at the Port of Dauphine and Villette, Paris; the Port Dauphine structure consists principally of a tunnel 250 m long and 13.5 m wide, having an elliptical concrete-arch roof; Villette tunnel is 200 m long; construction of tunnels.

GREAT BRITAIN. Experimental Work on British Roads. *Permanent Int. Assn. Road Congresses—Bul.*, vol. 21, no. 84, November-December 1932, pp. 210–218. Extracts from report for the year 1931 of Technical Advisory Committee on experimental work; Ministry of Transport Road Department; slippery roads; skidding; surfacing tests on Kingston by-pass; tests on snow- and ice-covered roads; treatment of such roads.

HIGHWAY ADMINISTRATION, FINANCING. How the Highway Pays—I, R. W. Crum. *Eng. News-Rec.*, vol. 110, no. 26, June 29, 1933, pp. 834–836. Liquidation of road costs by taxes; methods for studying relation between highway service costs and earning power as expressed by tax returns; annual highway cost; analysis for individual roads; estimated earnings; alternative bonding plan.

INDIA. Road Surfacing by Mix-in-Place Method in India, C. H. Haswell. *Roy. Engrs.—Journal*, vol. 47, June 1933, pp. 242–261, 2 supp. plates. Survey of Indian practical experience with hot-mix process and mix-in-place using cold bitumen emulsion; lessons learned from experiments; cost data.

IRELAND. Evolution of Road Administration and Transport in Northern Ireland, J. W. Leebody. *Inst. Mun. and County Engrs.—Journal*, vol. 59, no. 26, June 20, 1933, pp. 1450–1458. Road finance; road users; road upkeep.

LAWS AND LEGISLATION. Special Provisions for Highway Projects Under Public Works Bill. *Roads and Streets*, vol. 76, no. 7, July 1933, pp. 256–258. Employment lists; subletting or assigning contract; domestic materials; selection of labor; wages, hours of employment, and conditions of employment; hand-labor methods.

LOW-COST. Surface Treatment of Topsoil Roads, J. S. Williamson and P. F. Critz. *Am. City*, vol. 48, no. 7, July 1933, pp. 56–58. Experimental work of South Carolina State Highway Department in the development of inexpensive bituminous treatment for use on better class of topsoil and sand-clay roads; construction details; maintenance and retreatment costs; review of construction and maintenance practice resulting from experiments.

MAINTENANCE AND REPAIR. Mechanisation of Highway Works, A. H. Kennard. *Surveyor*, vol. 83, no. 2159, June 9, 1933, pp. 597 and 598. Improvements, surveys, plans, etc.; watching and lighting; keeping excavations free from water; provision of water for works; earth works; fencing and walling; drainage; bridges and culverts; raising covers of manholes, etc. (Concluded.)

MATERIALS, COTTON. Cotton Fabric Reinforcement of Road Surfacing. *Roads and Streets*, vol. 76, no. 6, June 1933, p. 235. Experience of laying cotton fabric membrane between layers of asphaltic surfacing on 2½-mile stretch of road near Baton Rouge, La.

ROAD MACHINERY, VIBRATORY. Vibratory Finishing Machine for Concrete Pavements, F. V. Reagel. *Am. Concrete Inst.—Journal*, vol. 4, no. 9, June 1933, pp. 391–396. Comparison between vibratory machine and regular-type Ord finisher; condition survey of test sections, after pavement had been subjected to traffic for four months, disclosed no differences in appearance or serviceability between vibratory-finished and standard-test sections.

SIGNALS AND SIGNALING. Crossing Gates Replaced by Flashing-Light Signals. *Ry. Signaling*, vol. 26, no. 7, July 1933, pp. 192–194. Street-crossing protection at Macomb, Ill., improved by removing gates, installing flashing-light signals, and closing six streets; part-time-manual control and special control for station provided; type of equipment used.

SINGLE-TRACK. Single-Track Concrete Roads Economical Low-Cost Type. *Concrete*, vol. 41, no. 7, July 1933, pp. 8 and 9. Roads built of standard concrete used successfully on main state and local roads; state and local route requirements; pavement design; construction and maintenance costs.

STREET LIGHTING, GREAT BRITAIN. Street Lighting Experiment at Croydon. *Elec. Times*, vol. 83, no. 2173 (Special No.), June 15, 1933, p. 768. New discharge lamp with improved color and higher wattage used in various streets of Croydon; particulars of installation and equipment; economies effected by new lighting.

SURFACE TREATMENT, CALCIUM CHLORIDE. Low-Cost Roads and Unemployment Relief, R. B. Traver. *Pub. Works*, vol. 64, no. 4, April 1933, pp. 27 and 28; (discussion), vol. 64, no. 6, June 1933, pp. 31 and 41–42. Experience of Onondaga County, N.Y., with calcium chloride treatment on gravel roads, as part of unemployment relief program; soil stabilization in highway construction through calcium chloride. Before Assn. Highway Officials of North Atlantic States.

TAR CONCRETE. Tar Concrete, W. E. Cone. *Surveyor*, vol. 83, no. 2161, June 23, 1933, pp. 645 and 646. Design of mixtures; durability; defects of fine-aggregate mixtures; conditions governing successful application, spreading, and rolling. Before Int. Road Tar Conference.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Contract Process, New Method of Artificial Biological Sewage Purification, F. Schimrigk. *Sewage Works Journal*, vol. 4, no. 3, May 1933, pp. 550 and 551. Translated abstract of paper previously indexed from *Gesundheits-Ingenieur*, Jan. 28, 1933.

CAST-IRON SEWERS. Cast-Iron Pipe Trunk Sewers in Washington Suburban Sanitary District, R. B. Morse. *Water Works and Sewerage*, vol. 80, no. 6, June 1933, pp. 192–196. Experiences gained in laying 3,745 ft of 30-in. pipe and 5,558 ft of 36-in. pipe in the Washington Suburban Sanitary District; author justifies the continued use of cast-iron pipe under present market conditions; unit costs of construction; comparative carrying capacities of sewers.

CHEMICAL TREATMENT. Chemical Treatment of Sewage, P. G. Lloyd. *Surveyor*, vol. 83, no. 2158, June 2, 1933, p. 578. Advantages of chemical treatment; combination with biological processes; results at Kingston-upon-Thames. Before Inst. Sewage Purification.

CHLORINATION. Chlorination at Downers Grove, Ill., Helps Solve Sewage Works Odor and Stream Pollution Problems, H. F. Ferguson and W. H. Wisely. *Water Works and Sewerage*, vol. 80, no. 6, June 1933, pp. 200–202. Description of Downers Grove, Ill., sewage works, with special reference to chlorination equipment; data on dissolved oxygen below sewer outfall.

DEARBORN, MICH. Chemical-Mechanical Treatment of Sewage and Sewage Sludge at Dearborn, E. C. Miller. *Sewage Works Journal*, vol. 5, no. 3, May 1933, pp. 447–457. Review of the sewage treatment practice of Dearborn, Mich., sewage disposal plants; plant loadings; operation and results.

DESIGN. Contribution to Design of Grit Chambers, H. Blunk. *Sewage Works Journal*, vol. 5, no. 3, May 1933, pp. 509–522. Formula for calculating dimensions of grit chambers' settling velocities of sand; design of grit chamber with five compartments brought into operation consecutively with increasing flow, by means of varying outfall weirs, and automatically cut out of service with decreasing flow; grit chamber at Bochum plant, Germany. Bibliography.

EQUIPMENT. Mechanical Equipment in Sewage Treatment Works, A. P. Folwell. *Pub. Works*, vol. 64, no. 6, June 1933, pp. 21 and 22. Addenda to previous chapters; grit chambers and bar screens; sewage and sludge pumps; use of chemical; general operating equipment.

GRAND RAPIDS, MICH. Study of Ferric Chloride Treatment of Sewage at Grand Rapids, Mich., E. F. Eldridge and N. G. Damoose. *Water Works and Sewerage*, vol. 80, no. 6, June 1933, pp. 207–210. Report on experimental study to determine the efficiency of ferric-chloride process under plant conditions also to obtain cost data; solids removal; bio-chemical oxygen demand reductions; reduction of bacteria; sludge production; effect on gas production.

INDUSTRIAL WASTES. Equitable Adjustment of Charges for Treating Trade Wastes—I, S. T. Powell. *Am. City*, vol. 43, no. 7, July 1933, pp. 45 and 46. Assessing the cost of the disposal of waste products discharged into surface watercourses, or into municipal sewerage systems; responsibility of industries; disposal by dilution.

LAWS AND LEGISLATION. Recent Court Decisions Which Have Bearing on Validity of Sewer Installation, L. T. Parker. *Mun. Sanitation*, vol. 4, no. 7, July 1933, pp. 236–238. Review of recent decisions of higher courts in the United States with reference to the market value of appropriated land; what assessments may include; notice of assessment; rights of contractors; etc.

ODOR CONTROL. Regulation of Chlorine Application in Sewage Odor Control Work, A. E. Griffin. *Water Works and Sewerage*, vol. 80, no. 6, June 1933, pp. 218 and 219. Methylene blue test revealing minimum effective dosage; practical demonstrations; relationship between chlorination and subsequent changes in sewage; comparative operating data of Princeton, N.J., sewage plant.

OPERATION. Results of Three Years of Operation of Akron Sewage Works, A. B. Backherms. *Mun. Sanitation*, vol. 4, no. 7, July 1933, pp. 229–232 and 238. Effects of overloading; performance; cleaning nozzles; humus tanks; accumulated sludge troubles; sludge beds, auxiliary drying beds, and lagoons; siphon overflow spillways and by-passes; analytical data and operating cost of entire plant. (Concluded.)

SLUDGE. Round Table. *Mun. Sanitation*, vol. 4, no. 7, July 1933, pp. 240–242. A practical discussion of the control and effects of pH on sludge digestion; 7.2 to 7.6 is ordinarily considered satisfactory; effect of pH values higher or lower than these.

TREATMENT, GREAT BRITAIN. Purification of Trade Wastes. *Surveyor*, vol. 83, no. 2159, June 9, 1933, pp. 601 and 602. Acid precipitation and activated sludge treatment at Halifax; grease recovery plant; Copley filtration works; activated sludge plants.

STRUCTURAL ENGINEERING

ARCHES, DESIGN. Unsymmetrical Concrete Arches—Determination of Moment, Shear, and Thrust at Crown, F. N. Weaver. *Boston Soc. Civ. Engrs.—Journal*, vol. 20, no. 5, May 1933, pp. 99–109, (discussion) 110–114. Outline of method based on solution of simultaneous equations; derivation of basic equations for deflection of curved beams, and horizontal thrust at hinges of unsymmetrical two-hinged arch; analysis of hingeless arch with fixed ends.

BEAMS, CONTINUOUS. Continuous Beam Design by Fixed Point Theory, O. Albert. *Eng. News-Rec.*, vol. 110, no. 26, June 29, 1933, pp. 842–844. Outline of graphical process based on Culmann method of fixed points, permitting construction of moment diagrams for any sequence of span lengths or any condition of loading.

CONCRETE SLABS, PRECAST. Precast Slabs Build Walls and Floors of Large Concrete Residence. *Concrete*, vol. 41, no. 6, June 1933, pp. 14 and 15. Double steel reinforcements in walls and partitions and two-way reinforcement in floors are featured; precast pan-shaped units for San Antonio residence are made on building site.

SURVEYING

LEVELING. Recent Areal Subsidence Found in Releveling, H. S. Rappleye. *Eng. News-Rec.*, vol. 110, no. 26, June 29, 1933, p. 845. Since 1920 changes in elevation of as much as 4 ft have been discovered over a large area centering around San José, Calif., by precise levels just completed; all indications that subsidence is still continuing.

TUNNELS

BELGIUM. Shield-Driven Tunnels near Completion Under Scheide at Antwerp, S. A. Thoresen. *Eng. News-Rec.*, vol. 110, no. 26, June 29, 1933, pp. 827–832. Article similar in contents to several other articles on the same subject indexed in Engineering Index of 1931, 1932, and 1933 from Belgian, French, and German publications.

CAISSON SINKING. Difficult Caisson Sinking for Vancouver Water Tunnel, W. Smaill and R. M. Wynne-Edwards. *Eng. News-Rec.*, vol. 111, no. 1, July 5, 1933, pp. 9–11. Open dredging used to sink caisson 24 ft in diameter and 130 ft deep; large boulders encountered at 100 ft drilled and blasted by diver; caisson, landed on sandstone, sealed and pumped out as start of 400-ft shaft.

CALIFORNIA. Coast Range Tunnel and Bay Crossing Nearing Completion in Hetch Hetchy Water Development, M. M. O'Shaughnessy. *Water Works Eng.*, vol. 86, no. 11, May 31, 1933, pp. 530 and 531. Progress report on the construction of the tunnels for the Hetch Hetchy water supply of San Francisco, Calif.; method of lining tunnels; bay crossing.

CONSTRUCTION, ACCIDENT PREVENTION. Safety Practices in Tunneling Operations at Hetch Hetchy Water-Supply Project, City and County of San Francisco, Calif., S. H. Ash and C. R. Rankin. *U. S. Bur. Mines—Information Cir.*, no. 6726, June 1933, 15 pp. Data based upon experience covering the period from Oct. 1, 1920 to Sept. 30, 1931, inclusive; brief description is given of tunnels in project; information shows relationship of tunneling operations to accident occurrence and costs.

VEHICULAR, SURFACE TREATMENT. Replaceable Sectional Paving for Vehicular Tunnels, A. Goertz. *Am. City*, vol. 48, no. 7, June 1933, pp. 37–40. Designs and experiments conducted under heavy traffic conditions in New York City; details of armored brick strips for vehicular tunnel roadways; experiments with brick and steel construction; steel-armored brick pavement at East Kingsbridge Road; replacement. Before Annual Convention of Nat. Paving Brick Assn.

WATERPROOFING. Sulla impermeabilizzazione delle gallerie, G. Pini. *Annali dei Lavori Publici*, vol. 71, no. 1, January 1933, pp. 1–44. Review of Italian practice in waterproofing of large railroad tunnels; cost data; text of specifications for lining and waterproofing of Vittoria tunnel.

INDEX TO ADVERTISERS

ALPHABETICAL

Industrial Index to Advertisers Shown on Pages 8 and 10